THE PONDICHERRY PROJECT

ON INTEGRATED DISEASE VECTOR CONTROL
(FILARIASIS CONTROL DEMONSTRATION PROJECT)

1981–1985

VECTOR CONTROL RESEARCH CENTRE
PONDICHERRY–INDIA

Views of

Prof. A.S. Paintal, F.R.S.
Director General, I.C.M.R.

'Paintal's two priorities are the control of mosquitoes using environmental approach and family planning using contraceptive pills'.

'On the control of malaria and filariasis, Paintal sees no need for new research. He says the only way to control these diseases is through elimination of the vector by environmental control, filling up ditches and improving sanitation. This approach has helped drastically to reduce the incidence of filariasis in Pondicherry and malaria in the Khera district of Gujarat. For the past 30 years, India has spent nearly half its health budget in the war against mosquit[illegible] says that ICMR has shown that the battle can be w[illegible]onment instead of spending money on research on

Quot

PROJECT REPORT
ON

"DEMONSTRATION OF CONTROL OF BANCROFTIAN FILARIASIS IN PONDICHERRY URBAN AGGLOMERATION BY CONTROLLING THE VECTOR *CULEX QUINQUEFASCIATUS*"

(1981 - 1985)

MUNITY HEALTH CELL

Road, Bangal

By

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1987

Smt. INDIRA GANDHI
Prime Minister

सत्यमेव जयते

New Delhi
7 January, 1981.

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MESSAGE

Filariasis, like malaria, is intimately related to environmental conditions. Filariasis causes varying degrees of discomfort, debilitation and deformity.

I am told that more than 236 million people in India are exposed to the risk of filariasis infection and that 18 million actually carry filariasis organisms in their bloodstreams. The progress in controlling the disease has been slow. We have decided to intensify these efforts.

I am glad that the Indian Council of Medical Research and the Government of Pondicherry have joined to develop an integrated strategy for mosquito control in Pondicherry. Studies have shown that in January 9 million mosquitoes emerge every day in Pondicherry alone. The number can be reduced only by improving and eliminating the drains, cesspools and pits where mosquitoes breed. This needs the active involvement of all people who must be encouraged to take keen interest in environmental cleanliness in every street and locality.

My good wishes for the Pondicherry project.

INDIRA GANDHI

Prof. V. Ramalingaswami,
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F.R.C. Path. (Lond)
Director General,
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NEW DELHI.

Message

We are at cross roads with regard to control of disease-carrying mosquitoes and of mosquito nuisance. Whatever may be the reasons, we have failed to consolidate our glittering successes in the early stages of the malaria eradication campaign using DDT as a residual indoor spray. Malaria, Filariasis, Kala-Azar and Japanese Encephalitis, all transmitted by insect vectors, are daunting us and we are not fighting a particularly successful battle against them. The reasons are a mixture of vector resistance to insecticides, technological inadequacy, knowledge gaps in epidemiology and vector biology and inefficient administrative and managerial strategies.

At this hinge of the history in the control of insect-borne diseases, new strategies putting the known- knowledge and technologies to more effective action are required. The integrated vector control project in the town of Pondicherry is a response to this challenge made by the ICMR'S Vector Control Research Centre working in close collaboration with the Government of Pondicherry. Such a project can only succeed if there is an active involvement of the people. It is a fore-runner of a wider application of this approach to the rest of the country. We cannot afford not to succeed.

1-1-1981

[V. Ramalingaswami]

TITLE OF THE PROJECT

DEMONSTRATION OF CONTROL OF BANCROFTIAN FILARIASIS IN PONDICHERRY URBAN AGGLOMERATION BY CONTROLLING THE PRINCIPAL VECTOR *CULEX QUINQUEFASCIATUS.*

OBJECTIVES

1. Development of appropriate methodology for vector control in a large town using integrated pest control technology.
2. Drastic reduction of microfilaria rate in the population of age group 0–5 years at the end of the project period by interrupting transmission.
3. Reduction in vector density and man vector contact.
4. Study of cost-benefit analysis.

DURATION AND FINANCING AUTHORITY OF THE PROJECT

1. Preparation time — 6 Months (July 1980 - Dec.1980)
2. Operation phase — 5 Years (January 1981 - Dec. 1985)
3. Analysis of data and preparation of final report — 6 Months (January 1986 - June. 1986)
4. Financing authority — Indian Council of Medical Research

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COLLABORATING AGENCY

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Government of Pondicherry, Pondicherry.

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(Duration: July 1980 — June 1986)

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PREFACE

We would like to dedicate this publication to the memory of the late Dr. T. Ramachandra Rao, the doyen of the Indian Entomologists, who had devoted his entire life time for the control of malaria,. filariasis and other arthropod borne diseases. He was the first in India to demonstrate environmental manipulation for vector control which resulted in eradiction of *Anopheles fluviatilis*, the malaria vector, from vast tracts of North Kanara Dist, Karnataka, in the pre-DDT era. But for his inspiration we would not have taken up the challange of demonstrating integrated vector control for filariasis in Pondicherry, the first in India. When the project was first inaugurated he sent a message on 24 January 1981 as follows:

> "*I am sure your inauguration ceremony was a success. I hope that the valedictory ceremony in 1985 will also be a great success. Hard work and yet more hard work alone will lead you to success which you must certainly deserve*"

Dr. Rao, inspite of his failing health, visited Pondicherry several times to look into all aspects of the integrated vector control programme. Whenever there was any occasion for despair, he used to sustain our interest by his advice and encouragement. The last letter dated 27 October 1983 which he wrote about this project reads as follows:

> "*The integrated control and environmental improvements are most important developments. However, they will require lot of dedication and hard work. If successful, as they are bound to be, they will be new watershed in our battle against vectors. However, utmost caution is necessary in assessment of results. They will undoubtedly be expensive in the beginning and will attract adverse comments. Already some people call it 'Utopian', but all new developments appear to be utopian. What did our friends say when we first demonstrated the utility of DDT in Dharwar and Kanara Districts in 1946–47? I am sure that in the long run environmental improvement will be economical and both scientifically and administratively feasible. Let it be clearly recognised, however, that environmental improvement will not work in* all *places till we know more about our vectors. It will work in more than half of our country, which would not be a mean achievement*".
>
> "*Here again environmental improvements and peoples' participation are for the present be kept apart though finally one cannot work without the other. What we need today is to demonstrate the techniques required for environmental improvement. Once we devise the techniques we can find out inexpensive methods of their application. Therefore I wish that in all your studies the two may be assessed independently.*"

In the following pages a detailed account has been given of planning, implementation and evaluation of the project. The success of this project should be evaluated not only by the results achieved, but also because this project has stimulated interest in Integrated Vector Management for disease control in other parts of India. There are at present over 15 such projects in different parts of India, and some of these like the Kheda Project in Nadiad District and the Pondicherry Village Project have already produced amazing results in malaria control.

April, 14, 1987.

DR. P. K. RAJAGOPALAN
Director.

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1. INTRODUCTION

Filariasis is a group of diseases caused by nematode worms belonging to the order "Filariidea", and transmitted to man by the infective bites of blood-sucking arthropods. Although "Filariasis" by the above terminology includes diseases like Onchocerciasis and Loiasis (caused by *Onchocerca volvulus* and *Loa Loa* respectively), in its common usage this term is commonly used to diseases affecting the lymphatics of man, and therefore termed as "lymphatic filariasis". Lymphatic filariasis in man is caused by three parasites namely, *Wuchereria bancrofti*, *Brugia malayi* and *Brugia timori*. Filariasis caused by brugian species is commonly known as "Brugian filariasis" and that caused by *W. bancrofti* is known as "Bancroftian filariasis".

Though mortality due to filariasis is negligible, there is a high degree of morbidity due to its acute and chronic presentations. The disease manifests itself in the form of lymphangitis, filarial fever, funiculitis, epididymo-orchitis during acute stages and the chronic phase includes elephantiasis, hydrocele and chronic oedema. In addition tropical pulmonary eosinophilia is also associated with filariasis (Danaraj *et al*, 1966).

The filarial parasites *W. bancrofti* and *B. malayi* spend a major part of their life cycle in man, the definitive host. A minor part is spent in the vector mosquito, the intermediate host. Though many species of vectors have been shown to be transmitting filariasis (either experimentally or naturally) (Das, 1976), *Culex quinquefasciatus* is the major vector responsible for transmission of bancroftian filariasis and *Mansonia* mosquitoes for transmitting Brugian filariasis in India. The adult worms of both the parasites are lodged in the lymphatic system of man. The female and male worms mate and the fertilized female which is viviparous, produce thousands of larvae known as microfilariae (mF). An adult worm is known to survive and continue to produce microfilariae for many years. A survival period of as many as 40 years has been recorded in one case of *W. bancrofti* infection (Carme & Laigret, 1979). Microfilariae appear in peripheral blood periodically and cannot develop further in human host unless they pass through the mosquito vector.

Microfilariae are ingested by mosquitoes along with blood, following which the mF sheds its sheath in mosquito gut. The exsheathed mF enter the thoracic muscle where they undergo two moultings to become the infective larvae. However, all the mF do not develop into infective larvae. The whole process of development of mF to infective stage needs 10–12 days in the tropical climate. These infective stage larvae migrate to the probocis of mosquitoes. When the infective mosquito bites man, the larvae escape through the proboscis and are deposited on the skin at the site of bite (Hairston & Jachowski, 1968). A few succeed in penetrating the wound, given ideal microclimatic condition and enter the human host (Ewert & Ho, 1967). Humidity plays an important role in successful penetration by the infective stage larvae (Lindsay *et al*, 1984). The interplay of various other factors responsible for successful penetration of the infective larvae and its development into adult stage in the human host is a complex phenomenon with many probabilities. Hence it is believed that a large number of infective bites are necessary for production of patent parasitaemia in man (Rajagopalan *et al*, 1977 & Hariston *et al*, 1968). Penetration by a single larva either male or female alone cannot result in patent microfilaraemia though the larva may grow to adulthood and the infected person may show clinical symptoms.

1.1. Global picture of lymphatic filariasis:

Inspite of the relative low efficiency of transmission when compared to other mosquito borne diseases like malaria, the disease in man continues to increase both in magnitude and direction. The magnitude and the geographical distribution of filariasis have been documented by various authors and agencies from time to time. According to a latest estimate (WHO, 1984), 2677 million people are living in countries where the disease is endemic, 905 million people are at the risk of infection (living in areas where transmission is active) and 90.2 million people are infected. Among the infected people 81.6 million are estimated to be infected with *W. bancrofti*. The data presented above are conservative estimates because epidemiological assessment of filariasis is complicated by

various factors like (a)non association of disease and mF positivity (b) prevalence of occult filariasis (c) periodicity of microfilaria, which necessitates night blood collection for detection and, (d) non availability of specific and sensitive diagnostic tools.

It is worthwhile mentioning that three countries, India, China, and Indonesia, account for two-thirds of all the lymphatic filariasis cases of the world (WHO, 1984).

1.2. Filariasis in India:

Both bancroftian and brugian forms of lymphatic filariasis are prevalent in India. Bancroftian form being the commonest, accounts for 98 percent of the infection and is transmitted by the ubiquitous mosquito *Cx.quinquefasciatus*. This form of filariasis is endemic throughout India excluding Jammu and Kashmir, Haryana, Punjab, Himachal Pradesh, Rajasthan, Tripura, Nagaland, Manipur, Meghalaya, Sikkim, Arunachal pradesh, Mizoram and Union Territories of Chandigarh and Delhi (Rao *et al*, 1976). Heavily infected areas are found in Uttar Pradesh, Bihar, Andhra Pradesh, Orissa, Tamil Nadu, Kerala, Gujarat and the Union Territory of Pondicherry. Brugian filariasis on the other hand, is restricted only to few pockets in Kerala, AndhraPradesh, Tamil Nadu, Assam, Orissa, Madya Pradesh and West Bengal. The central part of Kerala adjoining Vembanad lake in the districts of Alleppey Kottayam and Quilon is highly endemic for this form of filariasis.

Latest official estimates in 1981 (Sharma *et al*, 1983), show that 304 million people in India are reported to be exposed to the risk of infection, with an estimated 22 million mF carriers and 16 million chronic filariasis cases (Table 1).

TABLE 1. THE ESTIMATED POPULATION (IN MILLIONS) RESIDING IN ENDEMIC AREAS, THE MF CARRIERS AND CHRONIC FILARIASIS CASES AT DIFFERENT POINTS OF TIME.

Year	Population Residing in Endemic areas			mF carriers	Chronic filariasis cases
	Total	Rural	Urban		
1953	25.00	-	-	-	-
1962	64.24	40.16	24.08	5.30	4.40
1970	136.30	84.91	51.39	11.30	8.00
1976	236.14	174.53	61.61	18.00	14.00
1981	304.10	221.92	82.18	21.74	15.84

The present estimates suffer from certain limitations as the estimates are based only on the results of limited delimitation surveys carried out in different years at different places. In some districts the filariometric indices are based on small sample size. In many districts no recent surveys were carried out and earlier rates of the filariometric indices have been used for estimation which might have changed.

It should be mentioned here that filariasis surveys are yet to be carried out in 78 out of 290 districts spread over the endemic states (Sharma *et al*, 1983). No data are available on acute filarial illness. However, a citizens report (Agarwal *et al*, 1982), stated that every third person in India runs the risk of infection.

The estimated population exposed to the risk of infection has increased 12 fold during the last 3 decades. It was 25 million in 1953 (Jaswant Singh & Raghavan, 1953), 64 million in 1958 (ICMR, 1961), 136 million in 1968 (ICMR, 1961–70), 236 million in 1976 (Sharma *et al*, 1977) and 304 million in 1981 (Sharma *et al*, 1983). Various reasons have been attributed for such increase in space and time and some of these are listed below:

(a) More areas were surveyed, thereby detecting newer areas of transmission.
(b) Rapid urbanization of many areas leading to a breakdown of sanitary arrangements and migration of mF carriers from endemic areas to new towns in search of employment.
(c) Increase in population density in urban areas.
(d) Centrifugal spread of infection from urban to rural areas.
(e) Lack of an effective drug against adult worm.
(f) Poor acceptance of available drug of choice and failure to give adequate treatment to every detected mF carrier.
(g) General apathy of both officials and scientists towards filariasis problem since this is not a killer disease.
(h) A total neglect of the urban environment, resulting in the proliferation of vector mosquitoes.

1.3. Filariasis control in India:

The problem of filariasis control in India has been under intensive study for the last three decades. As early as 1949 a pilot scale control project was launched in Orissa State where three methods of control were used, viz. mass administration of the only drug of choice, Diethyl carbamazine (DEC), recurrent antilarval measures with malaria oil and recurrent anti adult mosquito measures by indoor residual spray of DDT at doses of 100 and 200 mg/sq.ft. Based on the results of the Orissa experiment, the National Filaria Control Programme (NFCP) was launched in 1956. The main objectives of the NFCP were, (a) to carry out filariasis survey in different states of the country, where the problem was not adequately recognised, (b) to undertake large scale pilot studies to apply and evaluate the known methods of filariasis control in selected areas, and (c) to train professional and ancillary personnel required for the programme.

Since filaria transmission takes place throughout the year adulticidal measures were required to be applied more frequently, which is not only impracticable and uneconomical, but this also increased the risk of precipitating resistance in the vector mosquito to insecticides. Therefore, residual insecticidal sprays against adult mosquitoes for filariasis control was discontinued in 1959 and larval control operation using malaria oil was made the main plank of operations against the vector.

Decrease in vector density, infection and infectivity rates in mosquitoes were shown to be well marked in areas where antilarval measures were efficiently carried out upto 1959 (ICMR Assessment Committee Report on NFCP, 1961). Based on the results of five years study the assessment committee concluded that antilarval measures will be the only practical answer for the control of vector of bancroftian filariasis. The committee also emphasized the role of environmental sanitation for the control of disease transmission and recommended that the control strategy should be classified under three headings, (a) minor engineering, surface drainage and creation of lidos, (b) desilting, deweeding and scum removal and (c) oiling of breeding habitats. The

efficacy of the methods were again assessed by Second ICMR Assessment Committee for the period 1961–70 and on the basis of the committee's report, the Ministry of Health, Govt. of India in 1969, laid down the following guidelines for filariasis control.

i) *Prevention of filariogenic condition in town expansion and in new townships.*
ii) *Adequate arrangement for disposal of sewage and sullage.*
iii) *Recurrent antilarval measures using malaria oil throughout the year along with minor engineering and desilting works.*

However, only routine antilarval measures using oil (part of the recommendation No: 3) is being undertaken by NFCP throughout the country without paying any attention to the first two major recommendations (adequate provision for sewage disposal and prevention of filariogenic conditions) because the responsibility for implementing the first two recommendations is not within the purview of the Health Departments.

Increasing cost of insecticide, concern for environmental pollution, resistance to insecticide in vectors and recurring operational expenditure and the inherent defects in the system like indiscipline among the workers and undue political interference, necessitated re-examining the utility of various methods of vector control in India and their impact on filariasis control, so that a realistic plan of action could be formulated.

1.4. Disease process and possible intervention points:

The disease transmission system in filariasis has three interacting components, viz., the parasite, the human host and the mosquito vector. Elimination of parasite from the system will result in eradication of disease. The possible intervention points are:-

i) Elimination of parasite while it is in human body. (Chemotherapy/Immunization).
ii) Elimination of parasite in mosquitoes. (Adulticidal measures).
iii) Prevention of transmission by (a) Reducing man vector contact either through personal prophylaxis or by reducing mosquito density, (b) Chemoprophylaxis and (c) Immunization (Fig. 1).

The advantages and disadvantages of each of the above method are discussed briefly.

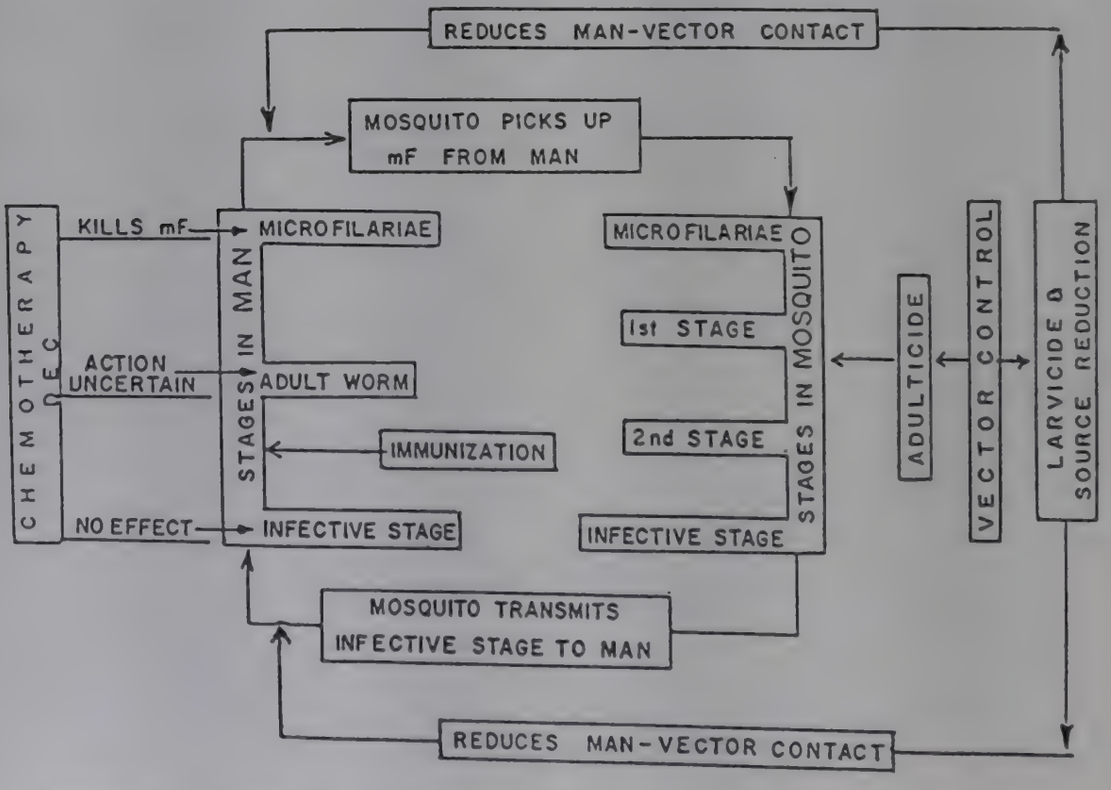


FIGURE 1. DISEASE PROCESS AND POSSIBLE INTERVENTION POINTS

1.4.1. Antiparasitic measures:

The only drug available, at present, for eliminating the filarial parasite in man is DEC. It is well documented, that mass administration of DEC is beset with several difficulties because of side effects (Ramakrishnan *et al*, 1960). In many patients even after the full regimen of treatment has been given some microfilariae do persist (Hawking, 1963), and mass administration of the drug through medicated salt has been successful in clearing microfilariae only for some time and that too only in isolated communities (Hawking & Marques, 1967; Raghavan *et al*, 1968; Katiyar *et al*, 1977). The effect of the drug on the infective stage larvae or on the adult worm in man is also not very clear. Due to these and other reasons, it has not been possible to prevent the spread of filariasis by administration of DEC alone. Chemotherapy must therefore be supplemented by an effective vector control programme, if the disease transmission has to be effectively prevented (Das & Ramaiah, 1987 in Press).

Immunization of population can offer an efficient method of preventing the spread of the disease. Though intensive research is being carried out on this aspect in different parts of the world, a vaccine is yet to be developed.

1.4.2. Antivector measures:

The principal vector of filariasis, *Cx. quinquefasciatus* has a very high reproductive potential and is an ubiquitous breeder. It has been shown that a patent case of filariasis is the result of a very large number of infective bites, as shown in Rangoon and Pondicherry. Transmission of disease is therefore the direct result of a very high vector density and only a drastic reduction of the vector density and maintaining the density at a low level can break the transmission. Effective vector control will not only reduce the transmission but is also desirable from the aesthetic point of view, since the vector mosquito is a major man biting pest in urban areas.

1.5. Integrated Vector Management (IVM) technique as an effective tool for vector control:

The concept of IVM as an effective tool for disease control was advocated since the last three decades. However, it has not gained much importance in public health programmes. This is mainly because of marked preference for age old methods and unwillingness to accept any new technology particularly because filariasis is a non-killer disease.

The method followed by the National Programme attempts to achieve vector abatement by the routine application of larvicide without considering the ecology and behaviour of target species in local conditions. The single chemical method for all types of situation was preferred mainly because it is apparently cheaper and unskilled personnel can implement and supervise. Control achieved by this process is generally ineffective and temporary.

In contrast IVM technique utilizes all suitable methods in an orderly and compatible manner. The IVM programme aims at reducing the vector population to a level at which disease transmission ceases to occur. The prime requisites for designing IVM strategy are (i) careful appraisal of ecological situation (ii) application of an appropriate method at the appropriate time (iii) utilizing highly skilled and disciplined manpower (iv) continuous monitoring and feedback of results to the operational team (v) enlisting community participation and (vi) coordinating the functions of different departments involved directly or indirectly in combating mosquitogenic conditions. If designed and implemented properly the IVM strategy would be cost effective in the long run.

In view of the above a vector control programme of a demonstrative nature was initiated for bancroftian filariasis control in Pondicherry by Vector Control Research Centre (VCRC). This Programme was launched in 1981 with the specific objective of developing an integrated vector control strategy which could be implemented in an urban set-up.

2. STUDY AREA

Pondicherry lies between 11.45° to 12.15° latitude north and 79.35° to 80.00° longitude east, on the Coromandel coast of Peninsular India. Pondicherry town and its urban agglomeration form the study area (Fig.2) (total area 59.38 Sq. kms population 272,250 1981 census). The semi-circular study area is demarcated by the Bay of Bengal in the east and the boundary arc passes from Veerampattinam, a coastal village in the south, along Ariankuppam, Pappanchavadi, Kombakkam, Ozhukarai, Gorimedu, Aurogarage (Mortandi) and joins Periamudaliarchavadi in north. All localities within this arc formed the study area for the Filariasis Control Demonstration Project (FCDP).

2.1. Climate:

The climate is characterized by humid summer, rainy days and a relatively cool season. Hence the climate is referred to as dissymmetric type (Legris and Viart, 1961). The data on rainfall, temperature and relative humidity are summarized in tables 2 & 3.

The common notion of the north-east (retreating) monsoon (October to December) bringing rains to the east coast of this area is not wholly correct (Legris, 1971). The rainfall during October to December is mainly due to the depression in the Bay of Bengal. The southwest monsoon is very strong on the west coast during June to September and traverses at irregular intervals through the western ghats and brings some rains on the east coast also. However, the peak of the rainy season is not centred towards the middle of the calender year (July) but is pushed towards the end of the year (November) because of the depression in the Bay of Bengal.

Temperature is one of the important physical factors influencing the life stages of mosquitoes. During the study period the mean maximum temperature ranged between 24.5°C and 37.5°C and the mean minimum temperature between 21.6°C and 27.4°C. The mean relative humidity ranged between 63.4% to 89.2%.

2.2. Population growth and process of urbanization:

During the last two decades the population in the study area has grown enormously. The urban population increased from 51,762 in 1961 to 272,250 in 1981. The growth of population and the urban area expansion during last two decades is shown in Table 4.

Because of the disproportionate growth of the urban population, housing problem became rather acute. Growth of the town and land use pattern which reflects the process of urbanization are depicted in Figs 3a & 3b. With the increase in demand for housing sites, land price went up drastically. Taking advantage of the situation promoters fragmented large agricultural land into housing sites and sold them to people without developing the land. While few purchased to satisfy their need for housing, a majority purchased for speculative purposes, and the agencies responsible for planned development were caught napping. The cooperative housing society was supposed to acquire land, develop it and sell house sites to its members on a non profit basis. The housing board's responsibility was to cater to the needs of the state government employees. The state town and country planning authorities were supposed to regulate the development by enforcing the existing rules of town and country planning. However, the rules were neither adhered to by the promoters nor enforced by the authorities. As a result numerous colonies sprang up in an unplanned manner. In these colonies many low lying vacant plots served as a disposal point for sullage and sewage. Numerous cesspits, cesspools and kutcha drains have proliferated providing ideal habitats for the filariasis vector.

2.3. Water Supply:

Protected water supply has been provided to the whole of the study area by three overhead storage tanks. As the water table is very high there are many hand pumps and open wells which are also used for several purposes. Since water supply is abundant in the study area, this has also led to

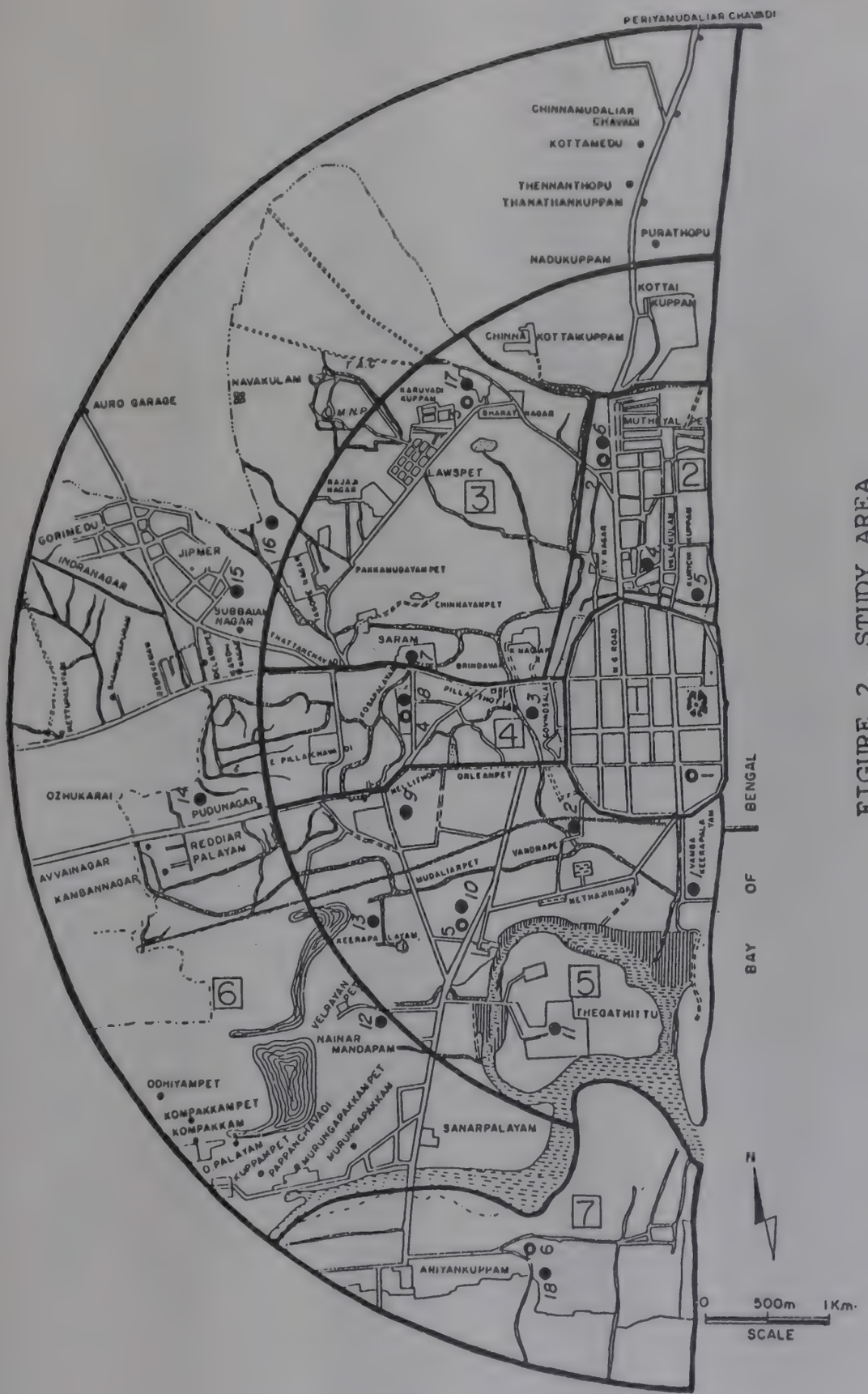


FIGURE 2. STUDY AREA

TABLE 2. RAINFALL IN MM IN THE STUDY AREA

Year	DIFFERENT MONTHS												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
1956-1980*	22.0	6.4	15.0	19.7	32.4	30.6	71.6	122.7	127.6	287.2	374.6	159.1	1268.8
1981	18.6	NIL	NIL	NIL	189.9	4.1	188.6	125.8	114.8	360.8	120.0	195.6	1318.2
1982	NIL	NIL	NIL	NIL	13.0	35.9	85.0	28.0	67.0	96.3	70.2	176.7	572.1
1983	NIL	NIL	NIL	NIL	17.2	6.2	48.1	144.2	100.4	227.7	363.3	267.8	1174.9
1984	33.8	188.6	25.8	8.4	NIL	10.0	129.2	75.0	177.2	71.0	145.4	41.2	905.6
1985	79.4	NIL	NIL	NIL	21.4	116.0	45.6	159.9	156.6	256.4	556.0	124.8	1516.1

* mean rainfall in mm for 25 years

TABLE 3. MEAN MAXIMUM AND MEAN MINIMUM TEMPERATURE IN °C AND RELATIVE HUMIDITY (RH) 8.30 HOURS AND 17.30 HOURS DURING THE STUDY PERIOD.

Month	1980				1981				1982			
	Temp.		R.H.		Temp.		R.H.		Temp.		R.H.	
	Max.	Min.	8.30	17.30	Max.	Min.	8.30	17.30	Max.	Min.	8.30	17.30
Jan.	28.8	24.0	79.7	79.9	29.1	23.4	79.8	84.1	28.9	22.5	82.8	81.7
Feb.	29.3	23.7	79.3	79.0	29.4	21.6	77.3	77.1	29.9	22.3	82.9	83.1
Mar.	30.6	24.2	80.7	84.6	31.2	24.7	76.6	75.0	31.1	23.3	75.9	77.3
Apr.	32.0	26.7	75.9	72.4	33.1	26.3	76.4	74.2	32.5	23.0	73.7	75.3
May	35.2	26.8	71.5	77.7	34.0	26.9	70.2	76.3	33.8	27.1	72.5	68.9
Jun.	36.3	26.9	70.5	71.1	36.1	26.7	69.2	62.6	36.8	26.5	63.4	68.9
Jul.	35.2	26.0	71.9	77.4	34.4	27.4	74.7	73.8	34.6	25.1	71.6	68.8
Aug.	35.0	26.0	79.4	77.0	34.3	25.1	74.9	75.4	35.4	25.5	67.8	66.0
Sep.	34.2	25.8	75.9	78.8	32.1	24.8	78.8	77.3	34.2	24.1	68.3	68.7
Oct.	31.8	25.2	77.9	72.3	31.9	24.7	81.1	79.6	31.4	23.9	72.6	73.2
Nov.	29.6	23.9	80.6	77.9	30.4	24.2	82.3	82.7	30.5	23.6	79.4	74.8
Dec.	28.8	24.4	81.9	77.5	25.7	22.8	84.9	85.7	29.3	22.2	78.6	76.9

TABLE 3 continued

Month	1983				1984				1985			
	Temp.		R.H.		Temp.		R.H.		Temp.		R.H.	
	Max.	Min.	8.30	17.30	Max.	Min.	8.30	17.30	Max.	Min.	8.30	17.30
Jan.	29.2	22.3	81.7	77.5	28.9	22.3	82.6	79.4	29.6	22.0	87.6	78.5
Feb.	30.6	23.0	77.2	70.6	28.7	23.4	84.9	82.7	30.5	22.4	84.0	78.3
Mar.	31.5	23.8	77.2	69.8	30.6	24.0	81.2	78.2	32.3	23.9	83.6	79.5
Apr.	32.3	23.9	75.9	69.5	32.8	25.9	74.6	72.9	33.4	26.8	74.5	73.4
May	34.9	26.8	66.3	69.3	34.5	26.6	72.5	72.1	35.3	26.9	70.9	72.5
Jun.	37.0	26.8	64.8	68.8	37.5	26.4	67.9	64.6	35.5	25.8	71.5	69.3
Jul.	33.1	26.4	75.9	76.9	33.8	24.5	77.8	75.5	33.5	24.9	80.3	74.4
Aug.	34.0	25.1	78.2	69.4	35.2	25.6	73.6	72.0	34.0	25.0	81.6	78.7
Sep.	32.5	24.8	77.0	88.9	30.9	24.3	77.7	75.6	33.6	24.4	82.4	77.9
Oct.	32.6	24.4	81.1	77.6	31.8	23.8	82.0	75.0	32.5	24.3	82.0	79.1
Nov.	30.4	23.1	75.1	75.7	29.9	23.0	87.0	81.0	29.0	22.8	86.5	83.3
Dec.	24.5	22.8	89.2	82.8	29.6	22.4	87.0	76.0	29.4	23.1	81.7	80.0

TABLE.4. GROWTH OF URBAN AREA AND POPULATION IN INDIA

Year	Total population	Urban	Percentage	Urban area (Sq.km)
1961	1 40,164	51,762	36.93	3.98
1971	1 92,007	1 54,945	80.70	29.51
1981	2 72,250	2 72,250	100.00	59.38

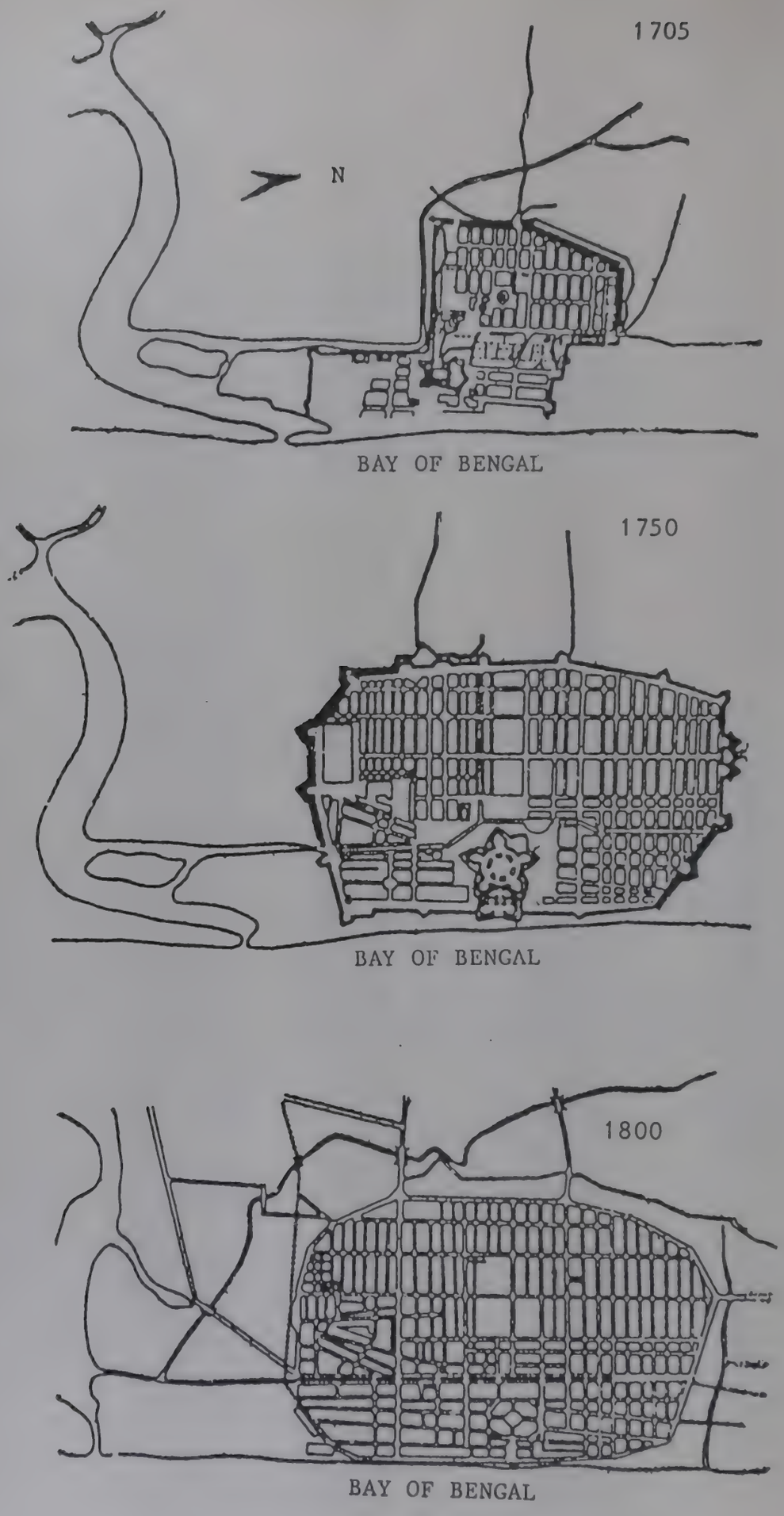


FIGURE 3a. GROWTH OF PONDICHERRY TOWN IN 1705, 1750 AND 1800.

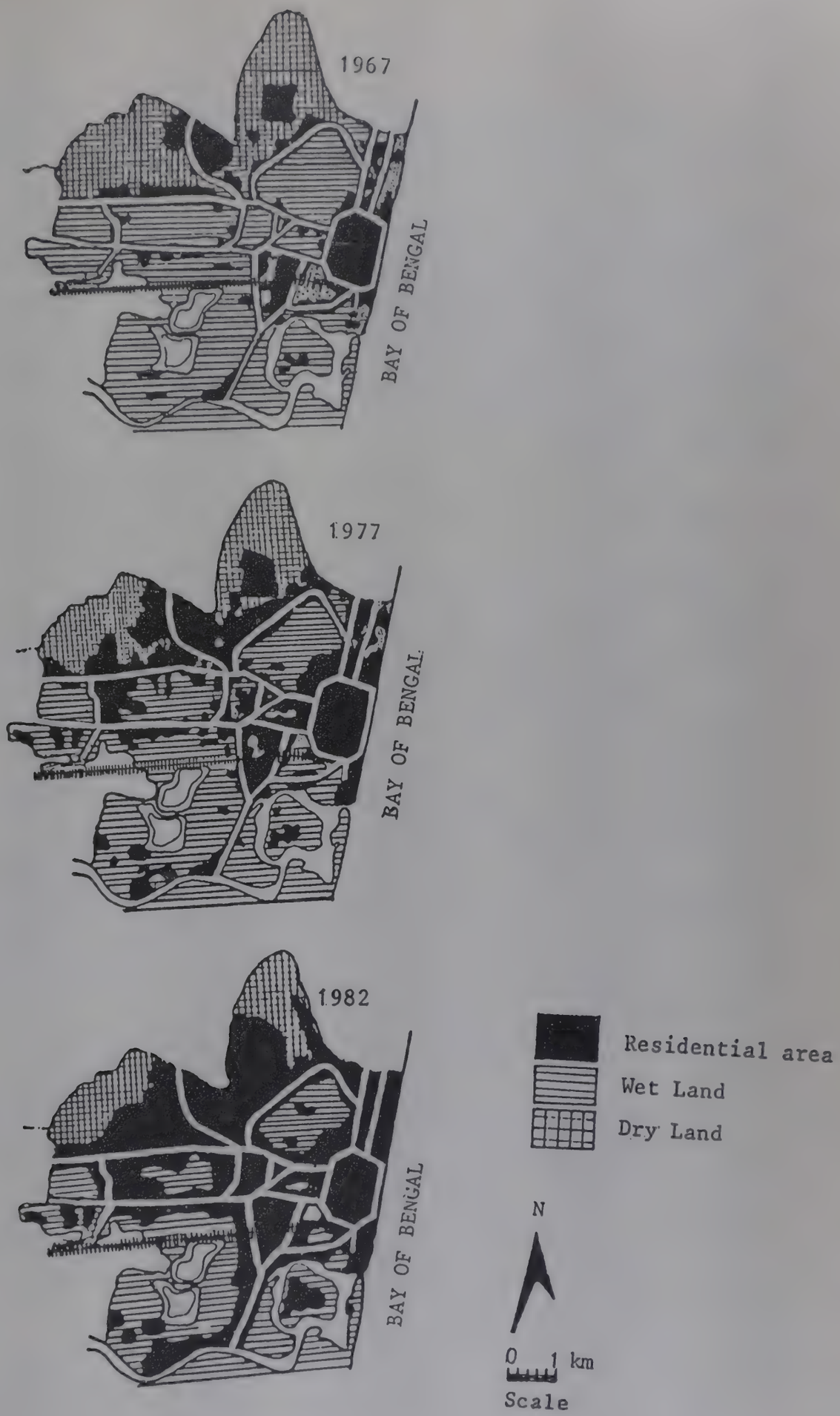


FIGURE 3b. GROWTH OF PONDICHERRY TOWN IN 1967, 1977 and 1982.

severe mosquitogenic conditions in the absence of an adequate drainage system.

2.4. Mosquitogenic condition:

It is well known that stagnant and polluted water bodies are the major breeding habitats for the filariasis vector *Cx. quinquefasciatus*. As stagnant water collection is favourable for vector breeding, one could expect reduction in breeding potential through proper waste water disposal and better sanitation, which however is grossly inadequate as described below.

Waste water disposal system in study area (Fig 4):

The waste water disposal for the old town was designed and constructed by the French. This consisted of 'L' shaped drains (Fig. 5) which ran in front of the houses and which carried sullage water and household effluents to the major canal known as Grand Canal (Fig. 6), which is 1.5 kms. long and with a cunnette. There were six outlets in the eastern side of the city for letting out the sullage water into the sea. The drainage system was adequate to dispose sullage and storm water and regular cleaning was easy. Since the open drains were running in front of houses, the house owners ensured that there was no stagnation. This system worked most efficiently, till the outlets of the Grand Canal were blocked due to inadequate attention. Thus a system which was working for years became non-functional. The water was then channelized to Dubrayapet area in the south, where it formed a large swamp resulting in large scale mosquito breeding.

Pondicherry town has expanded considerably in all directions since the French days, the expansion taking place in erstwhile lowlying agricultural lands. Due to unplanned urbanization, waste water and raw sewage from houses and colonies flowed into erstwhile irrigation canals. As a result polluted water was flowing at slow speed through the years stagnating along the course. The storm water canals are constructed with a slope of 1cm for every 100mt. which is sufficient to have a water flow rate of 1m per second when there is large amount of water. However, this occurs only seasonally when there is rain. For sullage water to flow the gradient should be much higher. Therefore, stagnation takes place in these canals except during rainy season, and facilitates breeding.

In many colonies there are no roadside drains to receive the effluents from houses. Wherever such drains were constructed they did not serve the purpose mainly because of faulty design and construction. The Government does provide the funds and the necessary administrative sanction but the planning and execution are invariably faulty. The execution is such that the new drains instead of solving the problems increased the mosquitogenic conditions. There is one major drainage/storm water canal (Uppar canal) (Fig.7) in the extended area, which was constructed to drain sullage as well as storm water. This canal is approximately 3km. in length and originates as a rain water collection in the adjacent Tamil Nadu State (Zone 3) and runs as a kutcha canal upto Venkata Nagar area and thereafter continues as a cement lined canal upto Dubrayapet swamp (Fig.8). There are five other storm water drains which also carry sullage water and join the Uppar Canal.

Lawspet branch:

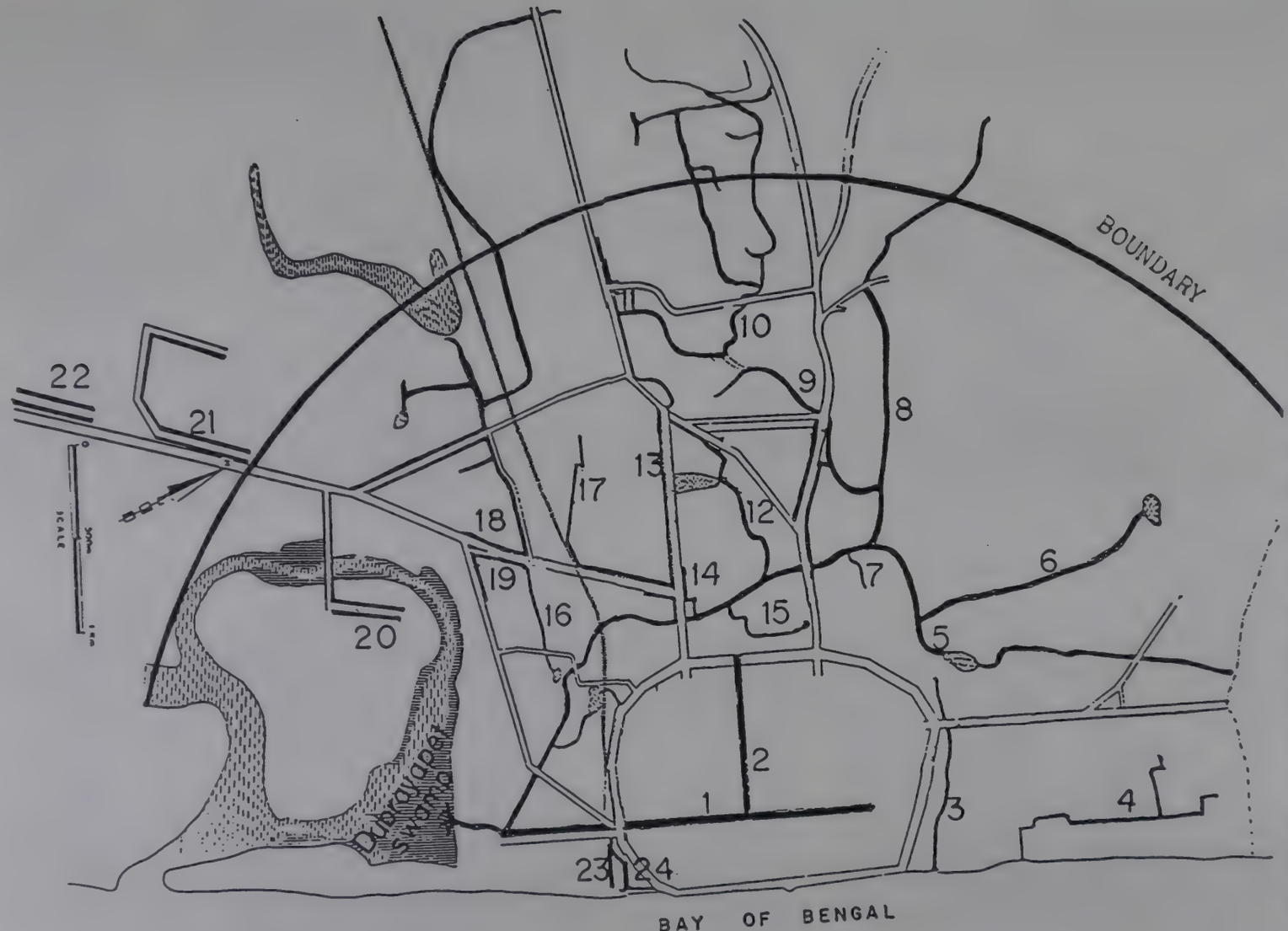
This is a kutcha canal collecting sullage water from the Lawspet and Karuvadikuppam areas and end up abruptly as a big pool near Thiruvalluvar nagar. Only when the volume of water is large, the water overflows into the Uppar canal.

Pakkamudayanpet branch:

A storm water canal (Fig.9) which collects sullage water from JIPMER, Jeevanandapuram, Subbiah Nagar and Thattanchavadi. Though it is flowing from an elevated area water stagnation occurs in many pockets because many large pits (burrow pits) are dug in the bed of this canal for taking soil for construction.

Ayyanarkoil drain:

This drain (Fig.10) passes through many colonies. All the sullage water collected by this drain is let out into a big pool in the heart of the town from where water sometimes overflows into the Uppar canal.



1. GRAND CANAL
2. PETIT CANAL
3. KURICHIKUPPAM CANAL
4. KATTAMANIKUPPAM BRANCH
5. UPPAR CANAL
6. LAWSPET CANAL
7. VENKATA NAGAR DRAIN
8. PAKKAMUDIANPET BRANCH
9. KOSAPALAYAM DRAIN
10. GUNDUPALAYAM CANAL
11. REDDIARPALAYAM DRAIN
12. IYYANAR KOIL DRAIN
13. NELLITHOPE DRAIN
14. PILLAITHOTTAM DRAIN
15. GOVINDASALAI DRAIN
16. MILL STREET DRAIN
17. MULLAI NAGAR DRAIN
18. MUDALIARPET DRAIN
19. BHARATHI MILL STREET DRAIN
20. THENGAITHITTU DRAIN
21. NAINARMANDAPAM DRAIN
22. MURUNGAPAKKAM DRAIN
23. PORT DRAIN
24. IT1 DRAIN

FIGURE 4.DRAINAGE SYSTEM IN THE STUDY AREA

'L' shaped drain in front of houses.

Grand Canal.

Uppar canal.

Uppar canal terminating in Dubrayapet swamp.

Pakkamudayanpet branch.

Ayyanarkoil drain.

Olandai drain or Mill street drain:

This was originally an irrigation canal starting from Olandai lake and running upto Vanrapet. When new colonies came up in this area, this canal was converted into a drain. This drain is lined to a length of only 0.75km. To have a shopping site over the drain, it was covered with slabs (Fig.11). The width at the top of the drain is 3 metres and at the base it is 1 metre. To support the slabs, pillars were then constructed in the canal and these pillars occupy more than 75 per cent of the surface area at the bottom (Fig.12). This has resulted in the permanent blockage of the drain. As the top is also closed, there is no possibility of cleaning the drain. Hence, this canal has become a 'sanctuary' for the mosquitoes in Pondicherry and is an 'engineering marvel'. This drain was originally planned to be connected to Uppar canal in Vanrapet area. After half of the drain was constructed it was found that the land for the other half was yet to be acquired. The construction work was stopped and this had resulted in the formation of a big pool in Vanrapet.

Thus, the Uppar canal carrying sullage from the expanding town joins Grand canal in the southern side of the study area, and the joint canal runs for 200 mt.. Though this joint canal was supposed to reach the sea, when the construction reached near the sea shore (about 150 metres from the sea) it was found that the level of the canal was two metres below the sea level and therefore the sullage water could not be let out into the sea. Further construction was therefore abandoned at that point. As the adjacent area on both sides of the joint canal was low lying, the sullage water started accumulating in the low lying area. During rainy season also, all the water collected from the town and colonies accumulated into this area and an area of about 70 hectares was thus inundated by polluted sullage water. This permanent inundation extended upto Thengathittu and is known as Thengathittu lagoon (Fig.13), another haven for mosquito breeding. The shallowness of the stagnated polluted water in this area was taken advantage by the people living in adjacent slums like Vambakeerapalayam etc., for making pits for soaking coconut husks for coir manufacture. Since the land belonged to the Government "porombokes" nobody bothered about the encroachments and about 4–6 hectares of shallow water area was thus encroached by the coir manufacturers. About 500 permanent coir pits (Fig.14) were thus created during the last 10 years. Since these pits had polluted water permanently, *Cx. quinquefasciatus* was found breeding profusely in that area. Only during the rainy season, the water finds its own course near Veerampattinam which is 2.8 kms. away from the planned exit.

In addition to these storm water canals, there are many 'U' shaped drains (Fig.15) which are capable of carrying effluents to the major canals. Many 'U' shaped drains are partially covered. The gradient being improper in many cases, water stagnates in pockets. Added to this, people use the drains as a convenient dumping place for garbage which blocks the flow of water and when not regularly cleaned these drains support prolific breeding of *Cx. quinquefasciatus*.

Kutcha drains (Fig.16) are unlined drains, dug to carry effluents and the problem is frequent clogging with mud resulting in stagnation and thereby facilitating breeding of *Cx. quinquefasciatus*.

Gully traps provided in 'U' drains form permanent depressions. Therefore, even if the gradient in the drain is perfect, water always stagnates in these depressions providing permanent breeding places.

In addition there exists an underground drainage system designed fifteen years ago for old town only, which was utilised by only twenty per cent of the household of old town. Many people who were not satisfied with the functioning of the system have reverted back to the old system. Thus in the absence of the comprehensive drainage system, polluted water accumulate in various places and according to their shape, size and degree of pollution these were classified into cesspits and cesspools.

Cesspits:

This habitat is purely man made and indispensable where facilities to dispose the sullage and sewage is not available. Generally these pits are about 1mt. in diameter (Fig.17). Each household digs up a pit for letting out the effluents and

Mill street drain covered with slabs.

Obstruction caused by pillars erected to support the slab.

Thengathittu lagoon — a vast inundated area.

Coir pits.

A typical 'U' shaped drain.

A kutcha drain.

A cesspit.

A cesspool.

as the water accumulates and stagnates these become the favourable breeding places for *Cx. quinquefasciatus*. This provides a stable habitat for the vector breeding. In Pondicherry cesspits are common sight in front of each and every house in many localities.

Cesspools and Vacant plots:

Vacant plots and cesspools are natural depressions of much larger dimensions and generally accumulate rain water. This type of water bodies being clear, do not provide favourable environment for *Cx. quinquefasciatus* breeding. However with increasing population pressure these water bodies soon become polluted due to dumping of solid garbage or by conducting waste water into them by people as well by governmental agencies. Thus the cesspools (Fig.18) become favourable breeding ground for filariasis vector. There are innumerable vacant plots (Fig.19) and cesspools in many localities in Pondicherry. The extent of breeding in this habitat depends on the degree of pollution which varies from place to place. While a majority of them are transient in nature permanent cesspools are not uncommon.

The other important breeding habitats are septic tanks, wells, storage tanks, water bodies around public taps, cattle sheds and receptacles. The contribution of these habitats for mosquito breeding is described below:

Septic tanks:

Septic tanks (Fig.20) are the major means of sewage disposal in the study area but for the few houses which are connected to underground sewage system. Septic tanks are provided with vent pipes for the escape of obnoxious gases and outlets for excess water. Since the over flow pipe is left uncovered in most cases, mosquitoes enter through these and breeding takes place. The excess water from the septic tank instead of being diverted to a soakage pit, is let into either a drain or allowed to form a puddle which breeds *Cx. quinquefasciatus*.

Wells:

Provision of protected water supply, being available to almost all houses, has led to disuse of existing wells. The dumping of garbage and letting out of the effluents into these convert them into breeding places (Fig.21).

Storage tanks:

Cement tanks of the size of 1 sq.mt. are built for storing water during construction work. Eventhough water in these tanks is not polluted, *Cx. quinquefasciatus* breeding is not uncommon.

Public taps:

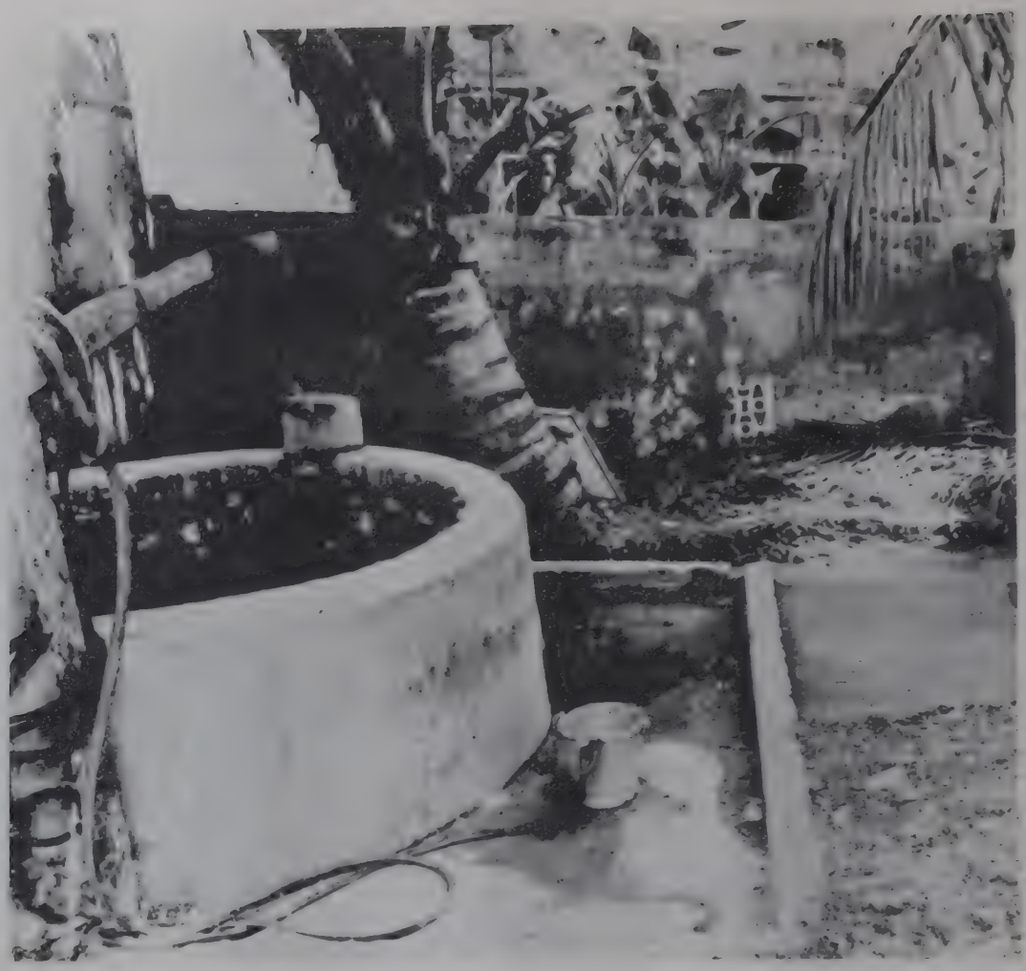
Due to leaky faucets, negligence and often due to pilferage of the taps, water goes on running from the taps creating mosquitogenic conditions around them (Fig.22).

Cattle shed:

It is a common sight to find milch cattle in many houses. These are tethered either inside the houses or on the roadside, due to lack of cattle sheds and without proper arrangement for removal and disposal of waste (Fig.23). Eventhough there is a legal provision for licensing of cattle sheds, it is not enforced. The Municipal Health authorities who have got sufficient powers to take action against the defaulters, are unable to enforce the existing rules. Just to cite one example, a cattle shed was constructed in a residential area without any waste disposal arrangement. When this was brought to the attention of the authorities concerned, a notice was issued. Prompt reply came from the owner that he is keeping these cows only as a hobby. But for reasons unknown, the matter was never pursued further. Such cattle roam about freely, and even the parks and markets are not spared. Buffaloes and pigs are also abundant in the area and are more problematic because they destroy the bunds of kutcha drains thereby creating ideal condition for *Cx. quinquefasciatus* breeding. Political interference with threats of transfer to inhospitable locations, or extending favours in some cases, are some of the causes for non enforcement of existing civic laws. Therefore the drainage and sanitary condition in Pondicherry gives a grim picture. No individual organization other than those responsible for sanitation can make any improvement in the existing conditions.

A vacant plot.

A septic tank.



A well.

Water collection around a public tap.

A cattle shed lacking waste disposale arrangement.

Receptacles.

Receptacles:

Domestic containers like mud pots, plastic containers, waste bottles, soap boxes, discarded tyres, coconut shells, tar drums, flower pots, and grinding stones etc., (Fig.24) also breed *Cx. quinquefasciatus* especially a few days after rain. Individually each of these habitat is of minor importance but collectively they still contribute substantially to *Cx. quinquefasciatus* breeding. Every house in the colonies thus contribute to the overall mosquitogenic condition in the area.

> "For the most part, man made foci of mosquito breeding can be attributed to the negligence and carelessness of construction engineers".
>
> —LE PRINCE IN 'MOSQUITO CONTROL IN PANAMA' (*New York and London,* 1916)

2.5. Filariasis situation:

2.5.1. Prevalence:

The first ever filariasis survey was carried out in Pondicherry in 1957 by a team from the filariasis training centre Ernakulam (Nair, 1960). The results obtained are given below:

Population of the town	59,835
Population surveyed	7,184
mF rate	10.3%
Infection rate	3.1%
Infectivity rate	1.4%
Disease rate	2.7%

Thereafter routine yearly surveys were carried out by the NFCP and the results are shown in Table 5. However, the data are not free from discrepancy, e.g., though infectivity rate remained nil for ten years transmission continued to occur. The data also showed a decreasing trend in disease inspite of persisting microfilaraemia during the same period. Because of these deficiencies, another survey was carried out by Rajagopalan *et al*, 1977 which showed 17.8% mF rate, 1.9% disease rate, giving endemicity rate of approximately 20%. This survey covered only some areas.

However, before launching the IVM project an extensive survey was carried out during January–June 1981 for collection of baseline data on prevalence of microfilaraemia. A total of 25,254 blood smears were collected by stratified random sampling with a proportionate allocation of 10 per cent. The average mF rate was found to be 8.59% with an average mF density of 10.72. Studies on the morbidity pattern revealed that chronic elephantiasis of leg forms one of the major manifestation of the diseased. The mF rates varied from locality to locality and ranged between 1.1% and 17.65%. This data formed the basis for evaluating efficacy of control programme. (For details see section 6.2.).

2.5.2. *Spread of Disease:*

It is stated that the bancroftian filariasis is an urban disease which spreads from urban to rural area (WHO, Tech. Rep. Ser. 1974). For studying the role of urbanization in spread of filariasis, Pondicherry and adjoining rural areas were divided into five concentric sectors (at 7km radius) radiating from seafront. Microfilaria rate, population density and vector density were studied in these sectors. It was found that the vector density, population density and mF rate declined towards the outer perimeters with low prevalence in the rural areas (Table.6) (Figs.25&26). Apparently rural areas of low endemicity become hyperendemic in the process of urbanization which bring about favourable ecological changes conducive for filariasis transmission.

TABLE 5 · PREVALENCE OF FILARIASIS IN PONDICHERRY (NFCP DATA)

Year	No. cases examined	No. +ve	mf. rate	Disease rate	Endemicity rate (mF rate + disease rate)	10 man hour density	Infection rate	Infectivity rate
1961	—	—	—	—	—	297.53	9.22	0.89
1962	83	11	13.25	Nil	13.25	177.94	5.96	0.37
1963	655	61	9.31	Nil	9.31	72.43	4.46	Nil
1964	5,610	437	7.78	Nil	7.78	65.48	2.22	Nil
1965	11,178	846	7.57	Nil	7.57	67.25	3.09	Nil
1966	10,829	727	6.71	Nil	6.71	66.95	3.43	Nil
1967	8,619	481	5.58	Nil	5.58	70.80	3.31	Nil
1968	8,926	511	5.73	Nil	5.73	62.24	2.55	Nil
1969	9,045	370	4.09	Nil	4.09	61.92	2.97	Nil
1970	10,429	674	6.46	Nil	6.46	51.40	2.30	Nil
1971	11,453	267	2.33	Nil	2.33	58.78	2.46	Nil
1972	12,456	855	6.87	Nil	6.87	60.59	1.55	Nil
1973	13,212	818	6.19	0.86	9.05	44.54	3.42	Nil
1974	—	—	—	—	—	41.08	2.95	Nil
1975	—	—	—	—	—	48.59	0.05	Nil
1976	—	—	—	—	—	37.80	0.06	Nil
1977	5,989	467	7.79	1.26	9.05	36.00	Nil	Nil
1978	2,850	154	5.40	0.11	5.51	34.40	Nil	Nil
1979	15,967	1408	8.82	0.57	9.39	26.80	Nil	Nil
1980	24,022	1174	4.89	0.62	5.51	53.97	1.20	0.24

TABLE 6. MF RATE, POPULATION DENSITY AND CULEX QUINQUEFASCIATUS DENSITY IN DIFERENT SECTORS

Sector No.	Mean distance in km.	No.of Blocks/ villages	No. of Blocks/ villages -ve for mF (%)	No. sampled	mF Rate	Population density/ hectare	Denisty of Cx.quinque-fasciatus per/man/hr
I	3.5 (0-7)	40	Nil (0)	25254	8.59 (1.11-17.69)	45.81	32.24
II	10.5 (7-14)	33	5 (15.2)	3442	4.07 (0-15.1)	6.85	2.45
III	17.5 (14-21)	31	12 (38.7)	3107	2.61 (0-13.9)	4.47	1.85
IV	24.5 (21-28)	25	7 (28)	2415	2.65 (0-11.1)	6.29	3.46
V	31.5 (28-35)	9	1 (11.1)	1203	2.41 (0-5.0)	4.43	0.5

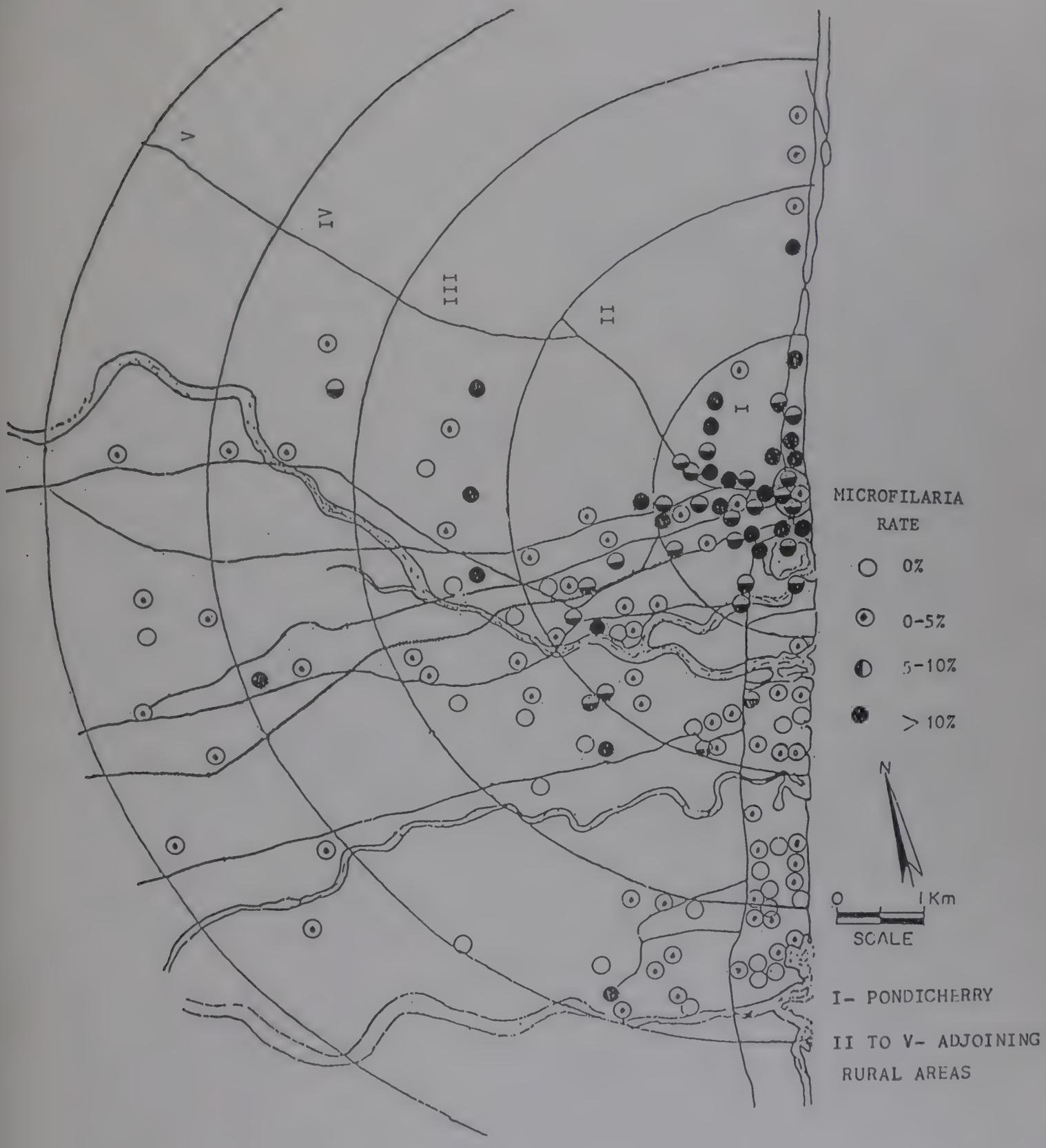


FIGURE 25. MF RATE IN PONDICHERRY AND ADJOINING RURAL AREAS

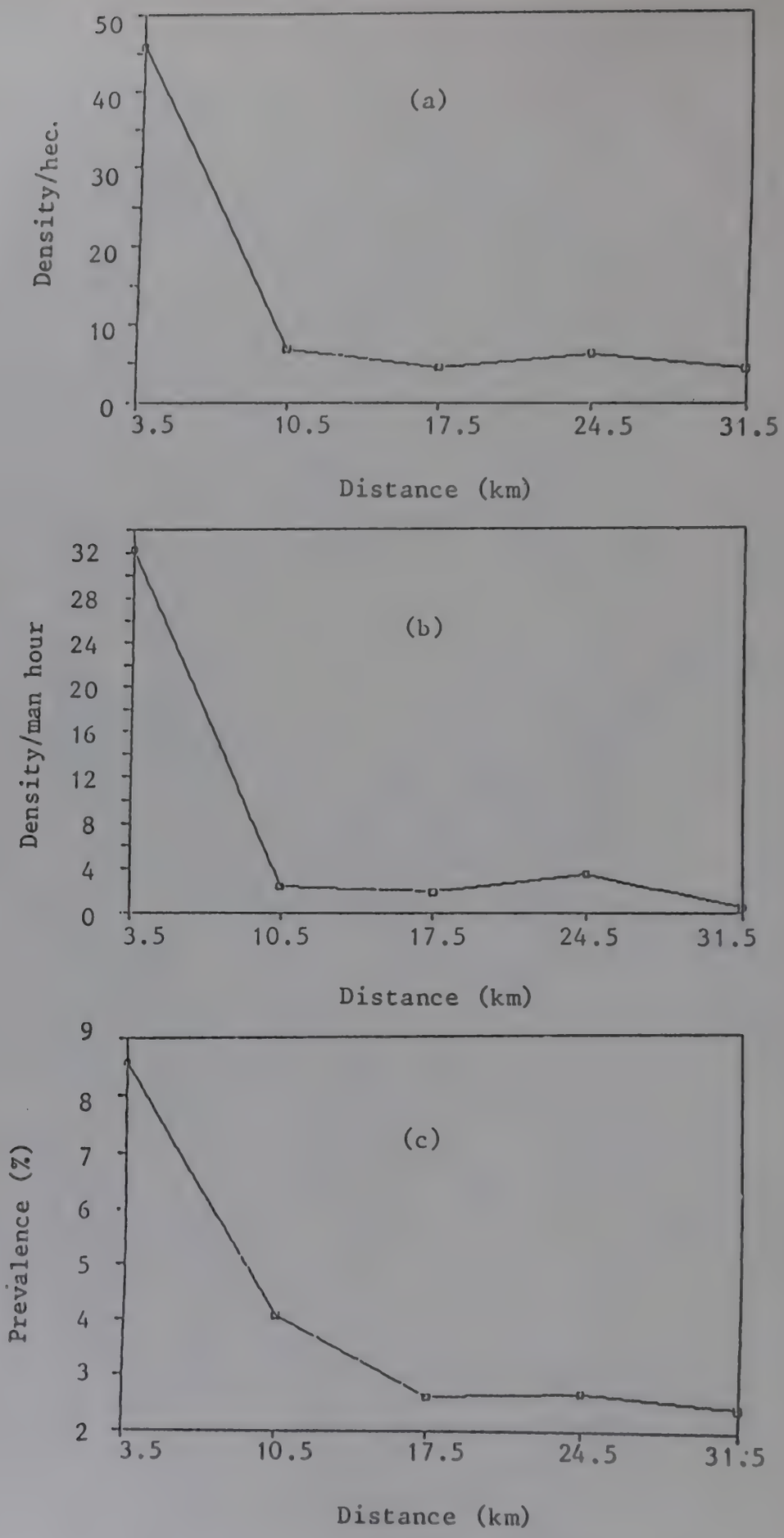


FIGURE 26. a) POPULATION DENSITY b) VECTOR DENSITY c) MF RATE IN AND AT VARIOUS DISTANCES FROM PONDICHERRY

3. CONTROL STRATEGY

Control of the vector was aimed to be achieved through Integrated Vector Management strategy which requires ensuring the co-operation of all the sections of the society, including officialdom, people and voluntary organization. All necessary information was first collected and the strategy formulated.

3.1. Collection of relevant information:

Intensive and extensive studies were carried out by VCRC for gathering information on epidemiology of the disease and ecology and behaviour of the vector species before launching this programme. The information utilized for formulating the strategy are described below:

3.1.1. Pondicherry is known to be highly endemic for filariasis. Endemicity rates varied from survey to survey as described earlier.

3.1.2. It was estimated that in Pondicherry one man is bitten by about 88,500 mosquitoes a year with an average of 242 mosquitoes per night (Rajagopalan *et al*, 1977).

3.1.3. Since 1.25 per cent of biting mosquitoes was found with infective stage larvae, on an average a man receives an estimated number of 1,106 infective bites per year. (Rajagopalan *et al*, 1977).

3.1.4. The annual transmission index which indicates the intensity of transmission was 5,178 in 1977 (Rajagopalan *et al*, 1977).

3.1.5. Assuming that a time period of $2^1/_2$ years is necessary to produce a patent infection in man, the estimated number of infective bites necessary to produce such patent infection is about 2,765 (Rajagopalan *et al*, 1977).

3.1.6. Pondicherry, having moderate temperature and high humidity throughout the year, provides conducive climate for efficient transmission of *W. bancrofti* throughout the year (Rajagopalan, 1980).

3.1.7. Extreme climatic conditions being rare in Pondicherry, the vector population size is regulated mainly by the extent of breeding surface area which varies from season to season (Rajagopalan, 1980).

3.1.8. The studies on the ecology of the *Cx. quinquefasciatus* in Pondicherry showed that the average daily emergence of this mosquito ranged from 172,900 during the rainy month of November to 9.6 million in the post-rainy month of January (Menon and Rajagopalan, 1980 (Fig.27).

3.1.9. This high density is maintained by over 100kms. of drains, thousands of cesspits, pools and wells and a large swamp. This is the direct result of unplanned urbanization and gross mismanagement of the environment over the years (Rajagopalan and Das, 1984). The drains contributed to 90 per cent of mosquito emergence in the post-monsoon months, and during rainy season the cesspits contributed to 45 per cent, the drains to 35 per cent and wells to 17 per cent of total mosquito emergence (Fig.28).

3.2. Formulation of strategy:

In the IVM strategy designed by VCRC, (Fig.29) emphasis was laid on the three aspects, viz., (I) Intersectoral collaboration (ISC), (II) Community participation, and (III) Integrated vector control by source reduction and other methods.

3.2.1. Intersectoral collaboration:

Since mosquitogenic conditions are created by several acts of commission and omission by the various départments engaged in developmental activities, intersectoral collaboration was sought so that these departments do not create additional breeding sources while implementing their programmes. Corrective steps were sought to be incorporated at the planning stage itself before new works were undertaken. Environmental improvement will not only result in mosquito control but also can drastically reduce the incidence of other water and environment related diseases.

A multidepartmental approach to control

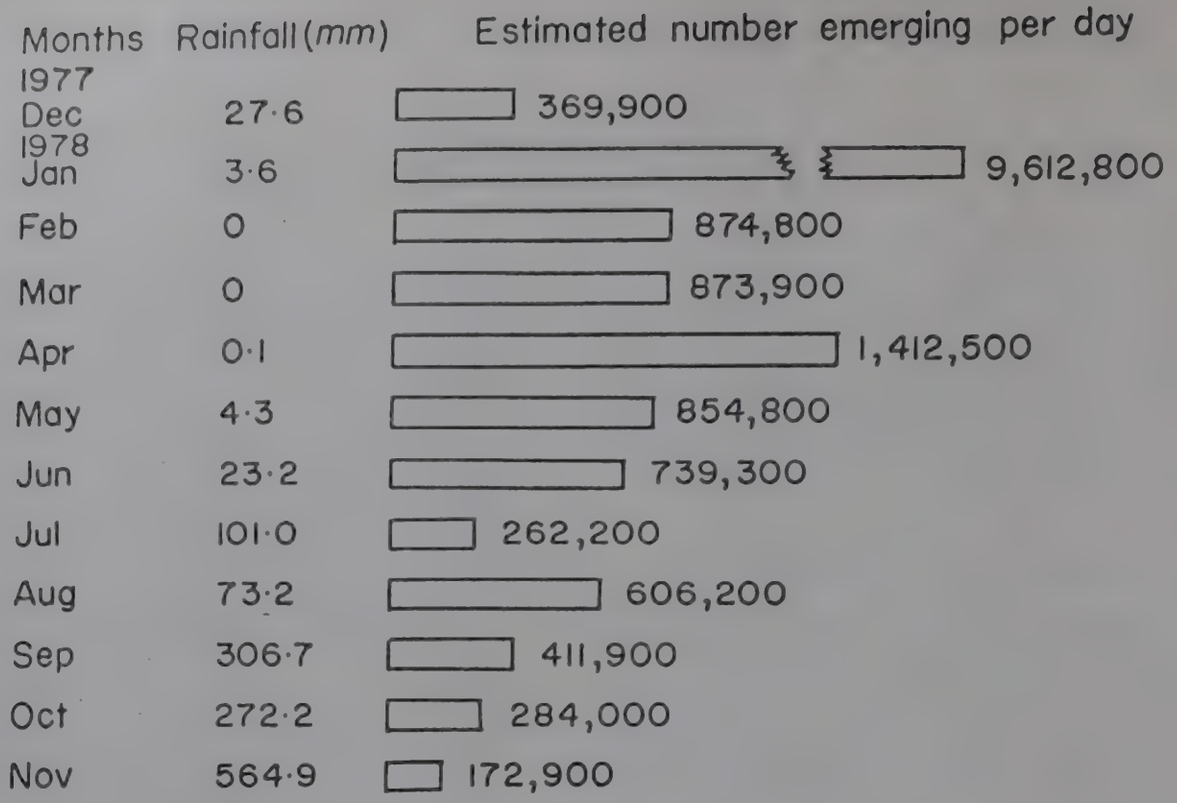


FIGURE 27. ESTIMATED NUMBER OF CX.QUINQUEFASCIATUS EMERGING DAILY FROM ALL HABITATS IN PONDICHERRY TOWN (10 sq.kms)

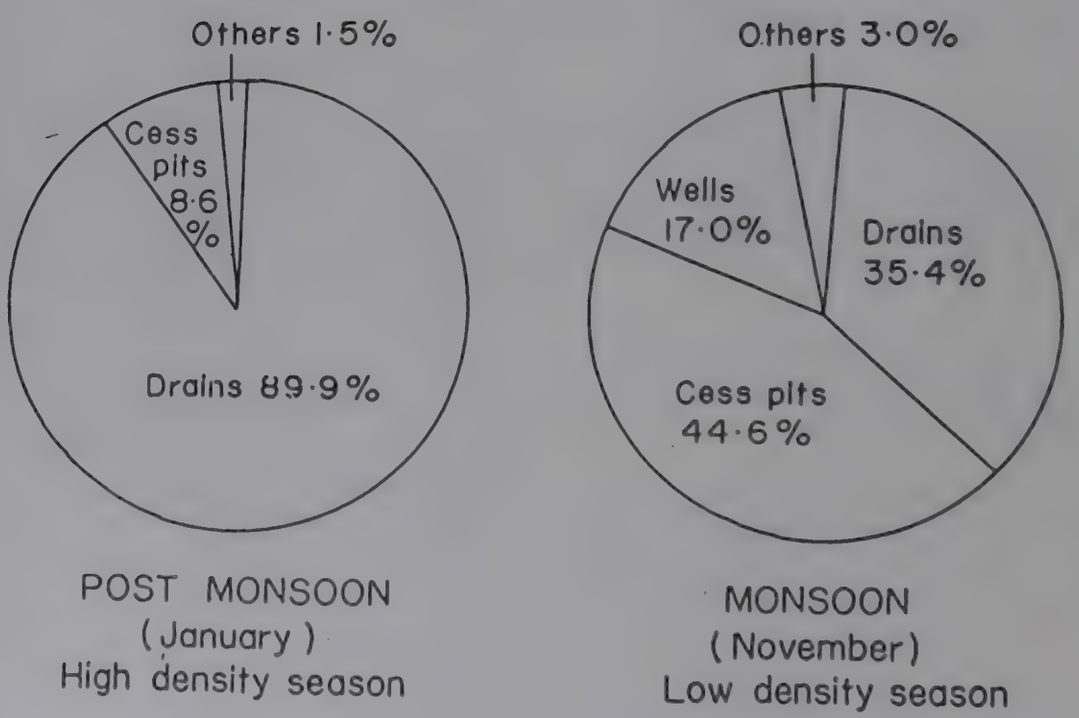


FIGURE 28. RELATIVE CONTRIBUTION OF DIFFERENT BREEDING HABITATS TO THE TOTAL DAILY EMERGENCE OF CX.QUINQUEFASCIATUS .

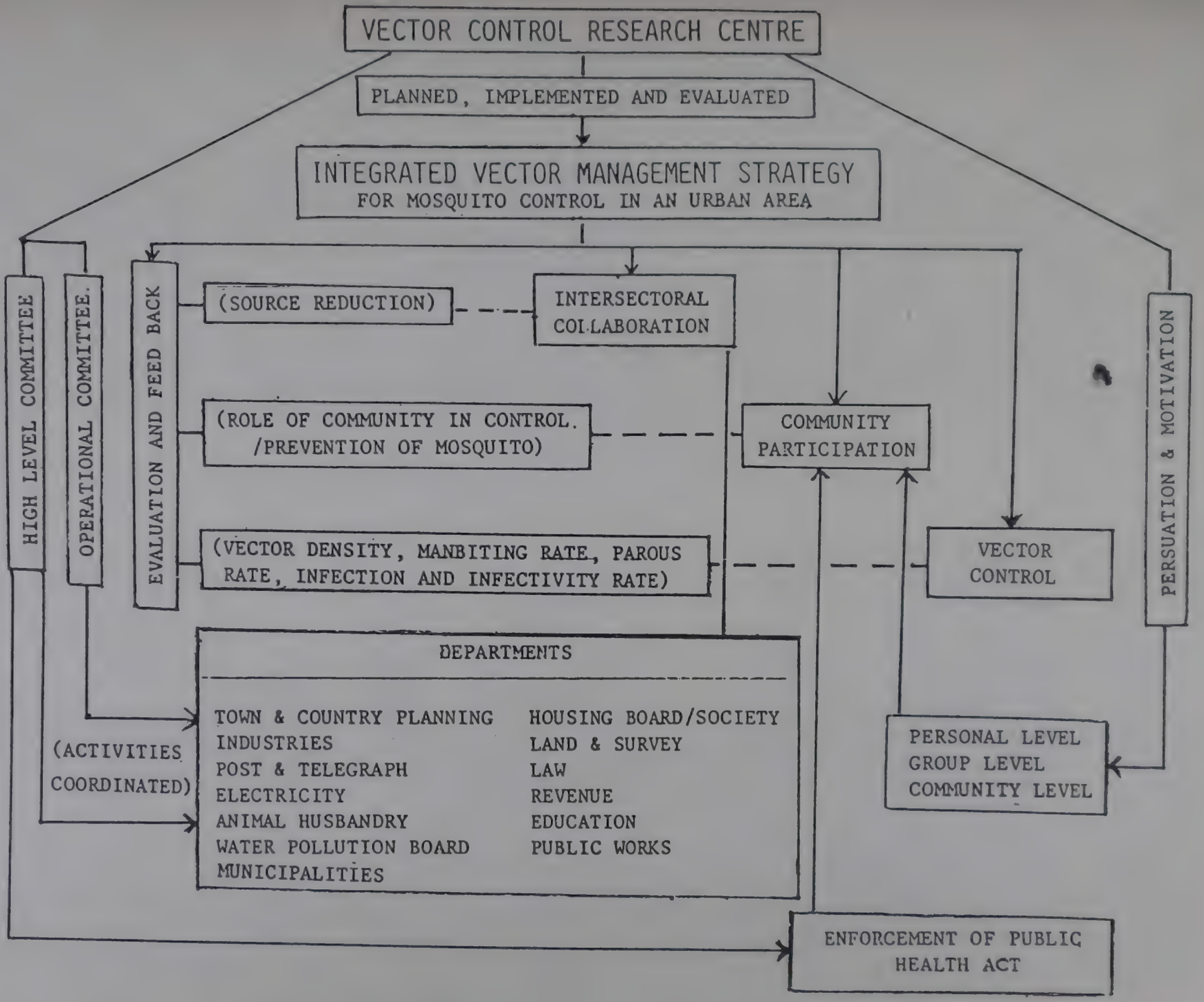


FIGURE 29. IVM STRATEGY AND ITS VARIOUS COMPONENTS

filariasis through vector control was therefore initiated. Two committees were formed to enlist cooperation of all the agencies which have some role in creating or preventing mosquitogenic conditions.

A High Level Committee (HLC) chaired by the Health Minister of the State/Chief Secretary of the Government met once every three months to review the implementation of the programme and to suggest remedial measures. Any bottleneck in the implementation of the IVM programme was looked into by this committee, which include

Health Minister (Chairman)
Chief Secretary
Health Secretary
Secretary, Local Administration Department
Director, Health and Family Welfare Services
Director, Public Works Department
Senior Town Planner&
Director, VCRC (Member Secretary)

An operational committee, chaired by the Director of Health and Family Welfare Services met every month to monitor closely the day to day implementation of this project and initiate corrective measures. The members included

Director, Health & Family Welfare Services
Director, Public Works Department
Senior Town Planner
Municipal Commissioners
Deputy Director, Local Admn. Department &
Director, VCRC (Member Secretary)

3.2.2. Community participation:

Several aspects of human behaviour directly or indirectly contribute in creating mosquitogenic conditions. Thus, the second key factor which needed change was the attitude of the community, which also includes the officials implementing various programmes. Unless and until these two sections participate and cooperate, the programme will remain a Governmental one with all the inherent pitfalls. A vertical Government programme without community involvement cannot deliver the goods. Therefore, enlisting community participation was emphasized in the VCRC plan by continuously educating the public on the dangers of insanitary conditions. The various media used included hoardings with catchy slogans and topical pictorial themes, wall posters, films and cinema slides, and through orientation training for group leaders and residents' associations.

Efforts were also made for enforcement of different civic laws which remained in the statute book for many years. Such enforcement can play a catalytic role in involving the community (See Section 5.2).

3.2.3. Vector control:

Environmental damage which had already taken place during the last two decades cannot be rectified overnight. Therefore, it was necessary that the vector population should be kept under check by appropriate methods for the duration of the project. Besides, the community (beneficiary) and the Governmental agencies could be made to realize the manifold advantage of a life free from mosquito bites. It was hoped that once the community gets conditioned to live a life free from mosquito nuisance, they would themselves come forward to maintain the gains. Past experience had shown that *Cx. quinquefasciatus* has adapted so much to human association that indoor residual insecticide spray under the National Malaria Eradication Programme (NMEP) had no effect in controlling this species. Their resting in inaccessible niches made adulticidal measures ineffective. Resistance development and incomplete coverage due to refusals are other restraining factors. Therefore, the only alternative method which is effective is by the control of immatures. The habitats of immatures are well defined and the major breeding habitats being outside the houses the question of refusals by house holders and insecticide avoidance by the species could be minimized. In urban situations larval control is more practical and economical.

Any larval control programme by routine application of insecticides must consider the high reproductive potential of the target mosquito species. Under the IVM strategy followed by the VCRC, drastic reduction in the carrying capacity of the environment (source reduction) was given the highest priority. Environmental measures like filling, channelization, desilting and deweeding were used. Other methods of control used in some habitats included biological, physical and chemical methods. Biological methods included use of

predatory fishes like *Gambusia* and *Tilapia* in such habitats where their survival is not endangered. Physical methods included closing of wells, hermetic sealing of wells and septic tanks, use of polystyrene expanded beads for preventing emergence and egg laying in wells, overhead tanks and cisterns etc.

Fenthion and Phenthoate (organophosphorus compounds) were the larvicides of choice used in many habitats, because laboratory studies showed slow resistance development (Das and Rajagopalan, 1981). Other insecticides (Organophosphates, synthetic pyrethroids, and juvenile hormone compounds) were also used on an experimental basis in some habitats. These insecticides were used judiciously in a mosaic pattern or by alternating them so as to delay the resistance development, which was constantly monitored. Similarly, mixtures of one or more compounds were also used and their effect evaluated. Monomolecular surface film like Monoxci and Arosurf were also used in some stagnant water bodies.

The relative importance of three major components of IVM technique as planned by the VCRC is compared to a house. Intersectoral collaboration and community participation are the foundation on which a stable IVM strategy can be built and environmental manipulation and source reduction can be compared with roofs and walls of the house, chemical control methods (insecticides) can be compared with curtains of doors and windows. The other methods of vector control like biocide, genetic control, predators, etc. are also useful in limited scale and can be compared with showpiece in the drawing room.

"If it is water, clean it (remove obstructions and vegetation); If it is standing water, move it (drain or fill); If it is moving water, compress it (reduce surface area); If it is hidden water, expose it (make it accessible to control and inspection)".

— F.W. Knipe (1953)

4. ORGANIZATION AND PLAN OF OPERATION

For sound implementation of control operations proper organization and planning of different activities is vital. Accordingly, the man power was organized and the suitability of appropriate control methods for different habitats, methods for evaluating the control operations were planned and the importance of different breeding habitats during different months was established.

> "Success of programs depend not only on the availability of adequate technical tools but also on the community's will and means to use these tools for best advantage. Thus it comes down to the problems of Good Management, Management and Training of Manpower, Management of financial resources, stimulation of public cooperation — all this in relation to existing need and conflicting priority".
>
> —BRUCE CHWATT

4.1. Time Schedule:

A time schedule is important in any vector control programme. Delays in initiating action can lead to emergence of millions of mosquitoes. Therefore, the Project Evaluation and Review Technique (PERT) plan of action was followed (Fig.30). All operations strictly followed the set time schedule. The progress of the project was reviewed every week and corrective changes made wherever necessary.

Recruitment and training of staff, procurement of equipment (including vehicles and supplies), standardization of methods, procedures and logistics were worked out in detail during the preparatory period of six months before launching the programme.

4.2. Demarcation of area:

The area was demarcated into seven operational zones based on geographic contiguity and operational convenience. Zones 1,2 and 7 covering an area of 11.34 Sq.kms were left under the routine NFCP operations.

In zones 3,4,5 and 6 covering a total area of 48.04 Sq.kms IVM strategy was followed by VCRC.

The population covered under the programme and the area in Sq.kms. in various zones are shown in Table 7.

For the purpose of larval evaluation these 7 zones were further divided into 60 Larval Evaluation Zones (LEZ) and for spraying purpose Zones 3,4,5 & 6 were divided into 20 spray zones (Table.8).

4.3. Manpower:

Trained VCRC scientists manned the project. Daily wage field workers were appointed on day to day basis. The total staff employed for this project included 15 scientists, 18 technical staff, (Technicians, Laboratory Assistants and Laboratory Attendants) 14 Superior Field Workers (SFW), 80 field workers, in addition to three drivers, one mechanic and three clerical staff. The budget allocated was Rs. 50 lakhs (US $500,000) for a period of five years.

4.4. Logistics:

A special cell looked after the organization and implementation of day to day programme and workers were asked to report at different working spots on different days. Implements

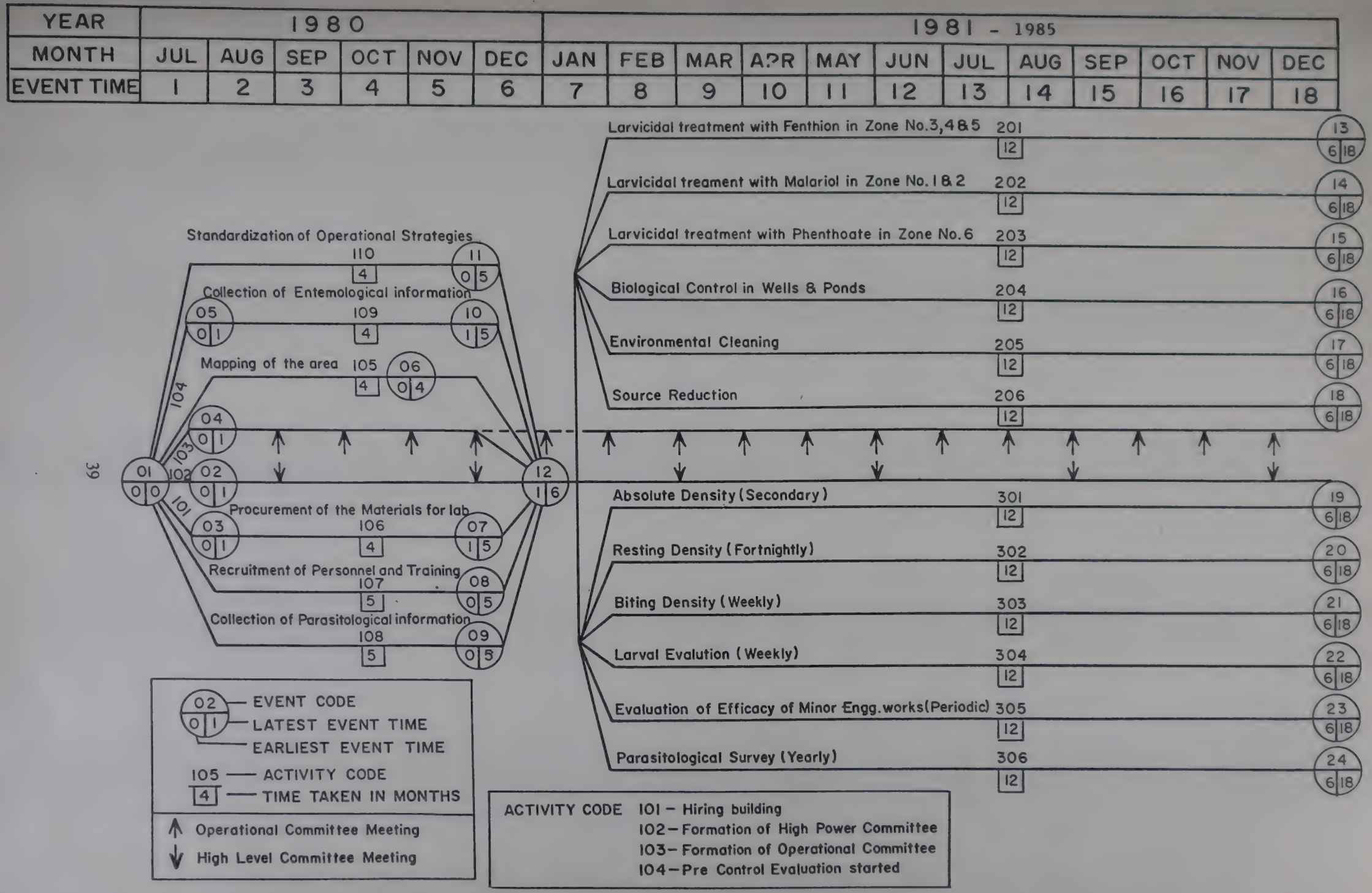

YEAR
1980
1981 - 1985
MONTH
JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
EVENT TIME
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Standardization of Operational Strategies
Collection of Entemological information
Mapping of the area
Procurement of the Materials for lab
Recruitment of Personnel and Training
Collection of Parasitological information
Larvicidal treatment with Fenthion in Zone No.3,4&5
Larvicidal treament with Malariol in Zone No.1&2
Larvicidal treatment with Phenthoate in Zone No.6
Biological Control in Wells & Ponds
Environmental Cleaning
Source Reduction
Absolute Density (Secondary)
Resting Density (Fortnightly)
Biting Density (Weekly)
Larval Evalution (Weekly)
Evaluation of Efficacy of Minor Engg.works(Periodic)
Parasitological Survey (Yearly)
EVENT CODE
LATEST EVENT TIME
EARLIEST EVENT TIME
ACTIVITY CODE
TIME TAKEN IN MONTHS
Operational Committee Meeting
High Level Committee Meeting
ACTIVITY CODE 101 – Hiring building
102 – Formation of High Power Committee
103 – Formation of Operational Committee
104 – Pre Control Evaluation started

FIGURE 30. PROJECT EVALUATION AND REVIEW TECHNIQUE(PERT)PLAN

LIST OF EVENTS AND ACTIVITIES

OF PROJECT MASTER PLAN

Activity code	Activities	Event code	Events
	PREPARATORY PHASE		*PREPARATORY PHASE*
101	Hiring building	01	Project Sanctioned
102	Formation of High Power Committee	02	High Power Committee Formed
103	Formation of Operational Committee	03	Building Acquired
104	Pre-control Evaluation Started	04	Operational Committee Formed
105	Mapping of the Area	05	Pre-control Evaluation Started
106	Procurement of the Materials for laboratory	06	Maps were drawn
107	Recruitment of Personnel and training	07	Laboratory Equipped
108	Collection of Parasitological information	08	Recruitment and Training Procedure Completed
109	Collection of Entomological information	09	Pre-control Parasitological Data Collected
110	Standardization of Operational Strategies	10	Pre-control Entomological data Collected
	CONTROL PHASE	11	Operational Strategy Developed
201	Larvicidal treatment with Fenthion in Zone No. 3, 4 & 5	12	Preparation Time Over
202	Larvicidal treatment with Malariol in Zone No. 1 & 2		*CONTROL PHASE*
203	Larvicidal treatment with Phenthoate in Zone No. 6	13	One Year Treatment with Fenthion Completed
204	Biological Control in Wells & Ponds	14	One Year Treatment with Malariol Completed
205	Environmental Cleaning	15	One Year Treatment with Phenthoate Completed
206	Source Reduction	16	Fish introduced in Wells and Ponds
	EVALUATION PHASE	17	Environment Cleaned
301	Absolute Density (Seasonal)	18	Source Reduced
302	Resting Density (Fortnightly)		*EVALUATION PHASE*
303	Biting Density (Weekly)	19	Absolute Density Measured
304	Larval Evaluation (Weekly)	20	Resting Density Measured
305	Evaluation of Efficacy of Minor Engineering works (Periodic)	21	Biting Density Measured
306	Parasitological Survey (Yearly)	22	Larval Evaluation Completed
		23	Evaluation of Efficacy of Minor Engineering Works Completed
		24	Parasitological Survey Completed

TABLE 7. ZONEWISE AREA AND POPULATION IN 1981

Zone	Population	House	Area in Sq. Kms.
1	58,426	4,513	2.80 (NFCP)
2	39,956	5,062	3.10 (NFCP)
3	35,060	4,849	10.20
4	23,151	2,947	2.40
5	56,523	5,720	11.42
6	48,856	3,422	24.02
7	10,278	1,059	5.44 (NFCP)
Total	27 2250	27,572	59.38

TABLE 8. LARVAL EVALUATION ZONES AND SPRAY ZONES

Zone	Name of the locality	Larval Evaluation Zone No. DEC 81 60-Zone	AUG 81 38-Zone	NOV 80 31-Zone	Spray Zone No.
1 (NFCP)	BOULEWARD I	1	1	1	
	BOULEWARD II	2	2	2	
2. (NFCP)	KURICHIKUPPAM	3	3	6	
	VALAKULAM	4	5		
	MUTHIALPET	5	5	3,4	
	VOC NAGAR	6	4	5	
	KUMARAGURUPALLAM	17	14		4
3	KOTTAKUPPAM	7	5	7,8	13
	KARUVADIKUPPAM	8	7	9	14
	PETTUCHETPET	9	7	9	14
	RAJAJI NAGAR	10			12
	TAGORE NAGAR	11	9	11	12
	LAWSPET	12	8	10	12
	THATTOTTUKALAPET	13			5
	SARAM	14	10	12	5
	BRINDAVAN	15	11	14	5
	RAINBOW NAGAR	16	13	15	4
	VENKATA NAGAR	18	12	13	4
	JEEVANANDAPURAM	19			12
	PAKKAMUDAYANPET	20			20
4	ELANGO NAGAR	21			6
	KENNEDY NAGAR	22	22		6
	ORLEANPET	23	21	22	7
	IYANAR NAGAR	24			6
	KOSAPALAYAM	25	16	17,18	10,11
	SATHYA NAGAR	26			10
	PETTIANCHATRAM	27	19,20		15
	MOHAN NAGAR	28	17	19	15
	ELLAPILLAICHAVADI	29	18	19	10,15,18
	GOVINDASALAI	30	15	16	3
	K.C. NAGAR	31			10
5	NELLITHOPE	32	24	21	7
	MUDALIARPET I	33	25	23	8
	MUDALIARPET II	34	25	23	8
	UPPALAM I	35	29		1
	UPPALAM II	36	29		1
	KEERAPALAYAM	37	28	20	9
	NATESAN NAGAR	38	23		9
	THENGAITHITTU	39	31	27	16
	VANARAPET	40	26	24,25	2
	KOLAS NAGAR	41	27		2
	VAMBAKEERAPALAYAM	42	30	26	1
6	JIPMER	43	37		20
	INDIRA NAGAR	44	37		20
	DELARSHPET	45	36		19
	KADIRKAMAM	46	36		19
	SOKKANATHANPET	47			19
	METTUPALAYAM	48			19
	SUBBIAH NAGAR	49	34	29	20
	OZHUKARAI	50			18
	REDDIARPALAYAM	51	33	30	18
	PAVALAKARANCHAVADI	52			18
	KAMBAN NAGAR	53	33		18
	VEEMAKOUNDANPALAYAM	54			19
	VELRAYANPET	55			16
	NAINARMANDAPAM	56	32	28	16
	MURUNGAPAKKAM	57	35	28	17
	KOMPAKKAM	58			17
	VICTORIA NAGAR	59			18
7 (NFCP)	ARIANKUPPAM	60	38	31	

required for operations were supplied on the spot. Checks were made by competent staff on the actual day to day work.

4.5. Deployment of man and material for various control operations and evaluation:

4.5.1. Physical and Environmental control:

Since environmental improvement through intersectoral collaboration was time consuming the VCRC itself undertook many environmental measures wherever necessary for the drastic reduction in the vector population.

Six teams each consisting of six field workers and headed by one SFW were deployed for environmental sanitation work. Four teams were deputed for desilting and deweeding of drains/ canals. The remaining two teams were deputed for (i) silt removal and filling up of low lying cesspools/vacant plots etc., (ii) channelization of kutcha drains, (iii) bailing out temporary water accumulation in different low lying areas and (iv) flushing the closed/covered drains with sea water.

Apart from these regular six teams, special squads were deployed additionally from the chemical and biological control teams whenever situation warranted. Work schedule is appended in Table. 9.

Equipments used for environmental sanitation work include, spades with handle, shovels, iron forks, crowbars, cleaning brushes with long handle, iron scrappers with long handle, cast iron pans, sickles, two 5 H.P. diesel pumps for bailing out water from the pools before filling, gum boots and ropes.

4.5.2. Chemical control:

Though the major emphasis of this programme is to control the vector by environmental sanitation and source reduction, chemical larviciding had to be done in several breeding habitats in many areas to bring about drastic reduction in vector density.

For spraying operation, Zones 3,4,5 and 6 were divided by the VCRC into 20 spray zones and the spraymen were deployed in such a way that each spray zone was covered weekly once. Spray schedule was such that it began at the centre of the heaviest populated area and moved towards the periphery. The operational schedule is shown in (Table 10, Fig.31).

Five spray zones were under the direct supervision of one team headed by one Research Assistant or Technical Assistant, who was assisted by two SFW and seven field workers for the necessary spraying operations. Four teams were deployed for complete coverage within five days for different spray zones. Each day four spray zones were completed.

Equipment and Maintenance:

30 Aspee(R) Hand Compression sprayers of 12 litres capacity (Code — ACS-4) and 25 SIKAR (R) Knapsack sprayers (Code-SR-28) of 16 litres capacity were used. Sufficient number of spare sprayers were kept for any immediate replacement. Sprayers were washed and cleaned, and the pump oiled every day to maintain it in perfect condition. Cost involved in sprayer maintenance was also recorded for each sprayer separately.

Transportation:

For the purpose of distribution of implements such as sprayers, scrappers, spades, brushes etc., and other chemicals needed in the field, two vans and one jeep were deployed. The staff and equipments were dropped early in the morning and picked up in the evening after the work was over. The vehicles movement as per day to day programme is shown in Fig.32.

Spray timings:

In order to avoid spraying during the hottest period of the day the time schedule followed for different months was:

Summer Months (March–June) 7.00 a.m. — 11.00 a.m. and 2.00 p.m. — 5.00 p.m. Other months (July – February) — 8.00 a.m. — 12.00 noon and 1.30 p.m. — 4.30 p.m.

Dosage determination:

In order to determine the minimum effective

TABLE 9. OPERATIONAL SCHEDULE FOR DESILTING OF DRAINS

Days	Team	Name of the drains	Zone	Nature	Length & Breadth (in Metres)
(1)	(2)	(3)	(4)	(5)	(6)
	1	Surya Gandhi Nagar Drain	3	K	110 x 1.0
		Venkata Nagar paddy field drain	3	K	405 x 0.5
		Asoka Nursing home drain.	3	K	412 x 1.5
	2	Vanarapet Railway campus drain	5	U	220 x 1.0
		Vanarapet drain	5	K	771 x 1.5
MONDAY	3	Iyyanar Koil drain	4	U	1065 x 2.0
	4	Uppalam road side drain	5	U	180 x 0.5
		Kolas Nagar drain	5	K	360 x 0.9
		Port Office drain	5	U	200 x 0.45
		ITI drain	5	U	160 x 0.45
		Park Guest House drain	5	U	150 x 0.45
	1	Orleanpet drain	5	U	630 x 0.9
		Thiruvalluvar Bus stand drain	4	U	200 x 1.0
		Kennedy Nagar drain	4	U	210 x 0.5
	2	Swedeshi Cotton Mill drain	3	U	255 x 0.5
		Thottakal drain (Nellithope)	5	U	175 x 0.54
TUESDAY		Vinoba St. drain	5	U	215 x 0.7
		Mullai Nagar drain	5	U	90 x 0.3
	3	AFT mill back side drain	5	K	620 x 1.0
		AFT mill street drain	5	U	650 x 1.0
	4	Mudaliarpet to Cuddalore road drain	5	U	405 x 0.3
		Bharathi mill street drain	5	U	560 x 0.3

K = Kutcha drain, U = "U" shaped drain, L = "L" shaped drain

Table-9 continued

(1)	(2)	(3)	(4)	(5)	(6)
WEDNESDAY	1	Kamarajar salai road side drain	4	U	400 x 0.5
		Balaji theatre drain (opp.to the	4	U	190 x 1.1
		Illango Nagar drain theatre)	4	U	288 x 0.55
	2	Sundaramestri street drain	4	U	850 x 0.3
		Vallalar street drain	4	K	180 x 0.3
		Pulliansalai road side drain	4	U	365 x 0.5
	3	Lenin st. drain (on both sides)	4	L	1240 x 0.3
	4	Keerapalayam drain	5	K	850 x 0.25
		Thengathittu drain	5	U	200 x 0.45
THURSDAY	1	Sathya Nagar drain	4	K	78 x 0.6
		Saram kutcha canal	3	K	1320 x 1.7
	2	Lawspet drain	3	U	210 x 0.5
		Pethuchettipet drain	3	U	355 x 0.5
		Karuvadikuppam drain	3	U	350 x 0.5
	3	Bharathidasan Nagar drain (Keeraparalayam road)	5	U	850 x 0.25
		Nainarmandapam drain	5	U	270 x 0.45
	4	Anna Nagar drain	5	U	650 x 0.5
		Vivekananda Nagar drain	6	U	210 x 1.7
FRIDAY	1	Reddiarpalayam drain	6	K	840 x 0.5
		Pavalakaran chavadi drain	6	U	283 x 0.75
	2	Gandhi Nagar drain	6	U	820 x 0.45
		Muthirapalayam drain	6	U	370 x 0.5
	3	Subbiah Nagar drain	6	U	220 x 0.75
		Indira Nagar drain	6	U	650 x 0.45
	4	Murungapakkam drain	6	U	280 x 0.5
				K	77 x 0.25
		Kombakkam drain	6	U	800 x 0.33

TABLE 10. CHEMICAL SPRAY OPERATION SCHEDULE WITH LARVAL EVALUATION ZONES (LEZ) IN PARENTHESIS.

Days	Monday	Tuesday	Wednesday	Thursday	Friday
Team No.	Spray Zone (LEZ)	Spray Zone (LEZ)	Spray Zone (LEZ)	Spray Zone (LEZ)	Spray Zone (LEZ)
I	1 (35,36,42)	8 (33,34)	9 (37,38)	16 (39,55,56)	17 (57,58)
II	2 (40,41)	7 (23,32)	10 (25,26,31)	15 (27,28,29)	18 (50,51,52,53, 59)
III	3 (30)	6 (21,22,24)	11 (25)	14 (8,9)	19 (45,46,47,48,54)
IV	4 (16,17,18)	5 (13,14,15)	12 (10,11,12,19)	13 (7)	20 (20,43,44,49)

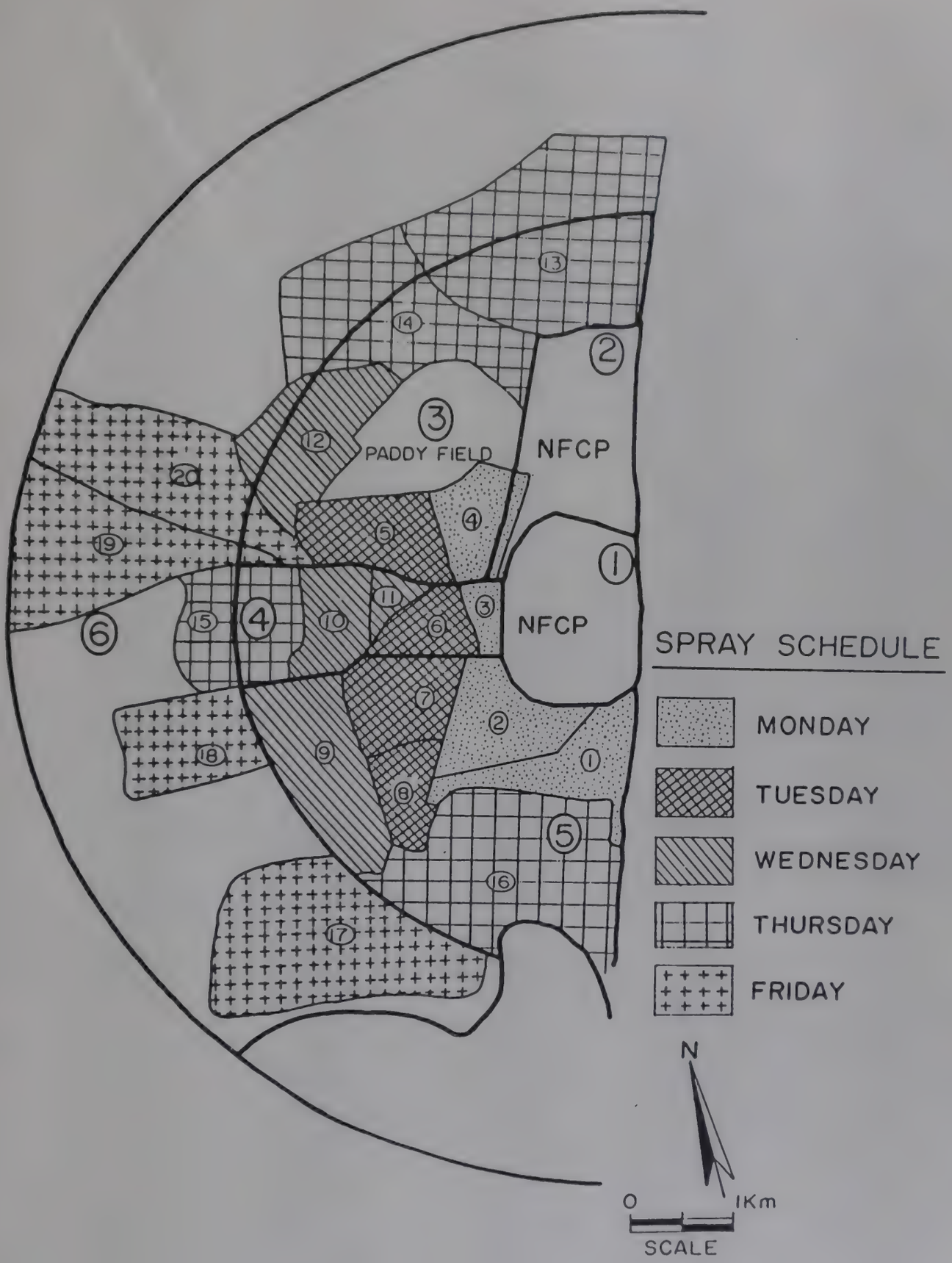


FIGURE 31. SPRAY SCHEDULE IN THE STUDY AREA

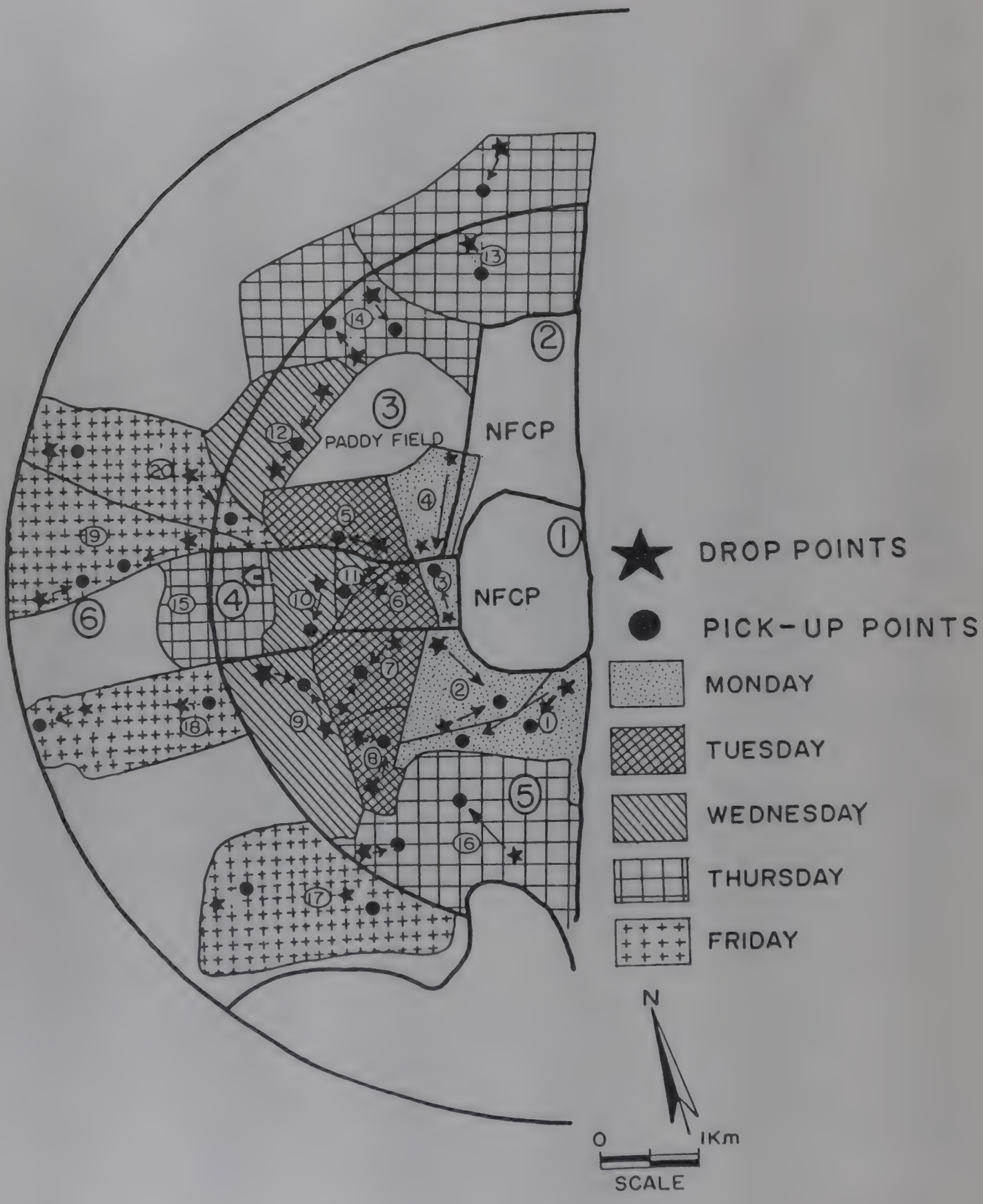


FIGURE 32. DROP AND PICK-UP POINTS FOR CONTROL TEAMS

dosage of fenthion and phenthoate, a field trial was done with 10 concentrations of fenthion and phenthoate in cesspits and drains. The time taken to give 100 per cent mortality was observed for different concentrations. To determine the frequency of spraying, persistance of insecticide in different habitats was also studied by bioassay, and residual analysis.

To evaluate cost factor the total amount of insecticide used for each round was also recorded.

4.5.3. Biological control:

The predator fish *Gambusia affinis* and *Tilapia* sp. were used in certain habitats. All the wells in the study area were surveyed and marked for mosquito breeding, presence of fish etc. Two teams each headed by one Technical staff and assisted by two field workers were deployed for this purpose. Fishes were collected from natural habitat and acclimatized in holding tanks before releasing into wells or cesspools.

4.5.4. Evaluation and feed back:

Since evaluation and feed back is essential for successful implementation of IVM strategy, the evaluation component was inbuilt in the operational programme and had two wings, i.e., larval evaluation and adult evaluation. The evaluation data were analyzed and discussed in group meetings and corrective measures were recommended for control operation. Though control operations were carried out by NFCP in zones 1, 2 and 7, evaluation in these zones also was carried out by VCRC.

Larval evaluation:

All the breeding places in the study area were marked and detailed maps prepared. Total surface area available was evaluated at six monthly intervals to find out the impact of source reduction.

For the survey of mosquito breeding habitats the total study area was initially subdivided into 31 larval evaluation zones (LEZ) and they were surveyed once a week. From December 1981 onwards LEZ were increased to 60. The survey programme was fixed in such a way that the area to be covered by the control team was surveyed one day in advance and the information passed on to the control teams for further action (Table 11).

Sampling procedures adopted in different habitats:

Breeding in cesspits, cesspools and vacant plots was assessed by dipper sampling method. (Fig.33) Number of dips to be taken depended on the size of the habitat. In drains sequential sampling i.e. one dip per 10 metre distance was taken (Rajagopalan *et al*, 1975). The average number of larvae and pupae per dip and percentage of dips positive were then calculated.

Bucket sampling method (Menon and Rajagopalan, 1978) was used in wells and the average number of larvae and pupae per bucket sample was recorded. Proportion of area breeding in each type of habitat was calculated. The emergence from each type of habitat was also calculated.

Adult evaluation:

The fluctuations in various parameters of adult population such as relative density, parity status and filarial infection rates were evaluated through indoor resting collection from 17 fixed catching stations, (Fig.34) and several random catching stations. The number of random stations evaluated varied from month to month. Three man-hours were spent to collect indoor resting mosquitoes. 3 or 4 well trained staff collected mosquitoes from a total of 12 huts/houses spending 15 minutes in each hut/house.

Fixed catching stations:

1. VOC Nagar (Zone 2, LEZ 6), 2. Muthialpet (Zone 2, LEZ 5), 3. Kurichikuppam (Zone 2, LEZ 3), 4. Saram (Zone 3, LEZ 14), 5. Karuvadikuppam (Zone 3, LEZ 8), 6. Jeevanandapuram (Zone 3, LEZ 19), 7. Govindasalai (Zone 4, LEZ 30), 8. Kosapalayam (Zone 4, LEZ 25), 9. Vambakeerapalayam (Zone 5, LEZ 42), 10. Vanrapet (Zone 5, LEZ 40), 11. Nellithope (Zone 5, LEZ 32), 12. Thengathittu (Zone 5, LEZ 39), 13. Mudaliarpet (Zone 5, LEZ 33), 14. Keerapalayam (Zone 5, LEZ 37), 15. Subbaiah Nagar (Zone 6, LEZ 49), 16. Reddiarpalayam (Zone 6, LEZ 51), 17. Nainarmandapam (Zone 6, LEZ 56).

The man vector contact was assessed weekly

TABLE 11. LARVAL EVALUATION SCHEDULE

DAYS	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Town No.	LEZ	LEZ	LEZ	LEZ	LEZ
I	13,14,15	37,38	2,39	57,58	35,36,42
II	1,21,22	25,26,31	27,28,29	49,51,53,54	40,41
III	23, 34	10,11	8,9	43,44,52,59	30
IV	24,33	4,12	3,7	45,46,50	17,18
V	6,32	5,19	55,56	20,47,48	16,60

LEZ - larval evaluation zone

Dipper sampling in breeding habitats.

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COMMUNITY HEALTH CELL
LIBRARY
AND
DOCUMENTATION
UNIT

FIGURE 34. FIXED CATCHING STATIONS FOR INDOOR RESTING AND NIGHT BITING COLLECTION.

through night biting collections from 5 fixed catching stations from different zones given below by spending 3 man hours in each station.

1. Bouleward (Zone 1, LEZ 1)
2. Muthialpet (Zone 2, LEZ 5)
3. Karuvadikuppam (Zone 3, LEZ 8)
4. Kosapalayam (Zone 4, LEZ 25)
5. Mudaliarpet (Zone 5, LEZ 33)

All night biting collection was done fortnightly from one catching station — Mudaliarpet (Zone 5, LEZ 33).

Other mosquito species were also collected to study species composition and population replacement, if any.

Parous rate, vector infection and infectivity rates in vectors were also determined regularly by dissecting the vector species.

Parasitological evaluation:

Cross sectional microfilaria survey was also carried out before launching and after the completion of project. The surveys covered 9.16% of the population in 1981 and 11.16% in 1986 covering all age groups. Post control survey attempted to follow up the population already covered in the pre-control survey. The detailed methodology is described in section 6.2.

Cost benefit analysis:

Cost benefit analysis of different methods was carried out. Since it was a package programme, the impact of different methods and their cost effectiveness was also monitored, particularly the quantum of insecticide used, manpower deployed for environmental work, etc.

4.6. Stratification of Pondicherry Town according to Vector breeding potential:

An important question faced by any vector control programme is to define priorities, particularly with reference to various types of habitats. Therefore, the stratification of area according to vector breeding potential is essential not only for planning and execution, but also for proper allocation of resources.

Though the urban filariasis vector can breed in any stagnant water collection, the major habitats contributing to mosquito production in Pondicherry are cesspits (including septic tanks), cesspools/vacant plots, drains and unused wells. For evaluating breeding status the study area was divided into sixty localities (LEZ) and breeding habitats were enumerated, surface area (Table 12) and breeding intensity measured and water quality assessed. Since the number of pupae moulting varied not only from habitat to habitat but also from locality to locality, the mean number of pupae per square metre of surface area in each habitat was first determined (Table 13). From the values of average number of pupae/Sq.m. and proportion of area breeding at a given time, unit area production (UAP) for different habitat was calculated. Since each habitat is unique in size, shape and the type of water it carried, the method of determining UAP also varied for different habitats and is described below:

Cesspit:

The surface area being small in comparison to other habitats, random sampling with a dipper (15cm diameter) was done in each pit. The number of pupae per dip was determined, from which the total number of pupae for the habitat was calculated. Number of pupae/Sq.m. was determined for each month, using the total number of pupae estimated and the total surface area of the habitat surveyed.

The percentage area breeding for pupae for the month was also calculated (Table 14) and the product of the number of pupae/Sq.m. and proportion of area breeding was the UAP of the habitat (Table 15).

Cesspool:

This being a larger water body more number of dipper samples were taken by stratifying the area into smaller units. The method of calculating UAP was the same as that of cesspit.

Well:

To estimate pupal production, five bucket samples were taken from each well and UAP was calculated by the same method used for cesspits and cesspools.

TABLE 12. POTENTIAL SURFACE AREA (Sq.m)OF DIFFERENT HABITATS

LEZ	CPIT	CPOOL	LDRAIN	UDRAIN	KDRAIN	WELLS	CANALS	TOTAL
1	0.00	0.00	3606.20	0.00	0.00	na	482.43	4088.63
2	21.92	0.00	8228.10	2924.50	0.00	1092.11	90.00	12356.63
3	12.66	0.00	0.00	0.00	0.00	49.10	2200.00	2261.76
4	71.36	399.24	0.00	680.00	178.80	71.27	0.00	1400.67
5	83.26	320.14	246.30	512.50	95.00	438.80	0.00	1696.00
6	42.55	5126.40	0.00	0.00	190.00	71.13	0.00	5430.08
7	46.56	177.57	0.00	0.00	0.00	447.07	0.00	671.20
8	17.22	116.85	120.00	669.20	817.50	121.56	0.00	1862.33
9	13.58	269.79	67.50	187.20	0.00	49.47	0.00	587.54
10	26.76	0.00	35.76	0.00	6.51	15.49	0.00	84.52
11	41.90	69.79	146.68	0.00	12.61	8.47	0.00	279.45
12	41.94	615.00	1404.00	269.00	78.00	48.82	0.00	2456.76
13	19.99	88.69	133.57	0.00	68.82	38.18	0.00	349.25
14	36.42	260.00	316.98	11.55	81.95	107.36	765.00	1579.26
15	60.97	908.27	220.49	314.38	11.00	54.38	0.00	1569.49
16	41.92	2289.73	0.00	0.00	400.00	0.00	0.00	2731.65
17	4.86	105.00	0.00	0.00	50.00	0.00	0.00	159.86
18	21.08	12397.15	885.60	0.00	796.35	7.93	0.00	14108.11
19	1.50	0.00	0.00	0.00	0.00	0.00	0.00	1.50
20	0.00	0.00	19.04	0.00	50.95	0.00	0.00	69.99
21	30.15	2218.35	162.60	225.00	44.80	3.99	0.00	2684.89
22	11.37	436.40	0.00	660.00	34.40	0.00	0.00	1142.17
23	44.16	3448.16	172.20	735.00	94.00	74.08	0.00	4567.60
24	9.31	1899.09	57.00	270.00	40.50	6.98	293.00	2575.88
25	42.41	1369.69	2242.71	561.94	785.87	173.96	0.00	5176.58
26	13.39	3977.00	222.00	0.00	51.00	0.00	0.00	4263.39

TABLE 12. Continued

LEZ	CPIT	CPOOL	LDRAIN	UDRAIN	KDRAIN	WELLS	CANALS	TOTAL
27	45.24	2,130.37	12.24	0.00	408.14	0.00	0.00	2,595.99
28	22.35	3,759.25	196.57	0.00	238.55	4.95	0.00	4221.67
29	11.07	26.80	100.70	70.00	162.40	95.14	0.00	466.11
30	83.45	92.87	487.38	617.40	224.38	61.84	0.00	1567.32
31	4.65	0.00	0.00	375.00	0.00	0.00	0.00	379.65
32	107.90	136.00	1,320.50	695.00	43.25	196.02	0.00	2,498.67
33	101.62	147.00	1,772.80	1530.20	0.00	326.35	0.00	3877.97
34	36.21	24.50	146.80	645.00	0.00		0.00	852.51
35	7.87	120.00	15.00	0.00	50.00	40.17	0.00	233.04
36	19.52	70.00	0.00	119.50	0.00		0.00	209.02
37	79.73	218.05	39.00	0.00	465.00	71.70	0.00	873.48
38	21.11	350.55	0.00	0.00	1050.00	139.23	0.00	1560.89
39	75.84	613.66	871.00	126.00	20.00	64.54	0.00	1771.04
40	121.10	280.15	69.00	496.00	1225.50	186.04	0.00	2377.79
41	23.56	55.91	813.00	108.00	120.00	20.43	0.00	1140.90
42	71.98	684.00	0.00	462.50	32.00	49.44	455.50	1755.42
43	173.25	0.00	0.00	135.00	45.00	0.00	0.00	353.25
44	12.93	0.00	0.00	598.00	45.00	0.00	740.00	1395.93
45	7.01	912.50	1447.20	571.00	228.60	17.21	0.00	3183.52
46	36.49	566.26	576.30	0.00	359.92	7.84	0.00	1546.81
47	22.46	125.70	138.00	0.00	100.00	11.63	0.00	397.79
48	19.47	25.16	164.00	0.00	80.00	18.57	0.00	307.20
49	38.11	49.86	588.00	0.00	143.00	5.81	0.00	824.78
50	39.29	293.75	1,479.60	18.25	51.00	197.63	0.00	2079.52
51	35.75	904.30	188.12	210.00	185.63	171.14	0.00	1694.94
52	4.95	33.31	144.00	49.00	20.00	36.47	0.00	287.73
53	3.45	800.00	225.20	0.00	12.71	0.00	0.00	1041.36
54	14.93	207.95	555.00	0.00	10.00	0.00	0.00	787.88
55	4.81	997.86	0.00	0.00	49.50	0.00	0.00	1052.17
56	38.56	71.25	72.00	0.00	79.50	40.70	0.00	302.01
57	43.35	139.03	0.00	111.00	60.00	111.57	0.00	464.95
58	30.08	90.53	246.00	136.50	15.38	137.03	0.00	655.52
59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	33.50	27.99	77.00	304.00	46.00	na	0.00	488.49
TOTAL	2,148.83	50,446.87	30,031.14	15,397.62	9,458.52	4,891.6	5,025.93	117,400.51

na - Not available

TABLE 13. MEAN NUMBER OF PUPAE/M^2 IN DIFFERENT HABITATS OF PONDICHERRY

Month	Cesspits	Cesspools	L-Drain	U-Drain	K-Drain	Canals	Wells
JANUARY	1,954	208	24	214	207	459	
FEBRUARY	3,248	1,293	196	2,766	217	516	
MARCH	2,060	19	2,587	372	336	69	
APRIL	2,299	105	108	311	0	66	
MAY	679	119	524	1,947	59	84	
JUNE	564	111	0	14	4	14	
JULY	598	11	73	327	19	9	
AUGUST	1,960	437	3	72	9	38	
SEPTEMBER	1,141	279	7	21	2	12	
OCTOBER	1,082	174	3	22	4	15	
NOVEMBER	570	35	14	21	5	14	
DECEMBER	545	200	1	25	199	10	
AVERAGE	1,392	249	295	509	88	109	366*

* Average of three rounds of survey.

TABLE 14 • PERCENTAGE AREA BREEDING OF TOTAL AREA IN DIFFERENT HABITATS OF PONDICHERRY DURING DIFFERENT MONTHS OF 1981.

Month	Cess pit	Cesspool	L-shaped Drain	U-shaped Drain	Unlined kutcha Drain	Storm water Canals	Wells
JANUARY	1.93	0.46	0.41	1.07	1.38	2.31	
FEBRUARY	2.08	1.54	3.28	2.42	1.58	3.93	
MARCH	0.91	0.29	0.51	1.46	1.17	1.02	
APRIL	1.16	0.26	1.06	0.87	0	0.53	
MAY	0.58	0.05	0.02	0.22	0.52	0.25	
JUNE	0.45	0.69	0	1.62	2.54	0.49	
JULY	0.55	1.99	0.93	6.98	1.21	0.23	
AUGUST	3.14	0.81	0.31	2.97	4.12	1.97	
SEPTEMEBR	3.12	0.57	0.13	0.95	0.58	0.78	
OCTOBER	1.96	3.79	0.10	1.07	0.66	0.62	
NOVEMBER	1.52	0.27	0.19	1.04	1.42	1.20	
DECEMBER	1.14	1.20	0.38	1.77	1.11	4.10	
AVERAGE	1.55	0.99	0.61	1.87	1.36	1.45	3.68*

* Average of all the rounds

TABLE 15. UNIT AREA PRODUCTION (UAP) IN DIFFERENT BREEDING HABITATS IN PONDICHERRY DURING DIFFERENT MONTHS OF 1981.

Month	Cesspits	Cesspools	DRAIN SHAPE *				Wells
			L	U	Kutcha	Canal	
JANUARY	37.71	1.	0.04	7.83	11.44	19.63	
FEBRUARY	67.56	20.0	1.48	112.03	8.15	25.07	
MARCH	18.75	0.05	14.73	10.70	12.73	4.49	
APRIL	26.67	0.27	0.80	5.59	0	2.23	
MAY	3.94	0.06	2.37	35.58	2.14	2.90	
JUNE	2.54	0.77	0	1.49	0.50	0.87	
JULY	3.29	0.22	0.77	33.63	0.66	0	
AUGUST	61.54	3.54	0	3.18	0.35	6.72	
SEPTEMBER	35.6	1.59	0	1.95	0.07	1.12	
OCTOBER	21.21	6.59	0	1.95	0.31	1.12	
NOVEMBER	8.66	0.09	0.02	1.85	0.28	1.40	
DECEMBER	6.21	2.40	0.004	3.54	2.02	4.71	
Mean	24.47	3.05	1.44 **	14.50 **	3.04 **	6.03 **	14

* Obtained by taking weighted average of length and UAP of different localities.

** Weighted average of length and total length of drain in each month.

Drain:

Because of discontinuous and clumped distribution of larvae and pupae in drains, sequential sampling was done at 10 mts interval. The number of pupae/Sq.m. was calculated and also the percentage area breeding for pupae. UAP was derived by multiplying number of pupae/Sq.m. by proportion of area breeding. Since the length of the drain as well as the quantum of pupal production varies from one locality to another, the weighted average of UAP for this particular habitat was considered by pooling UAP from different localities. Since the two values can be expected to vary with the season, UAP was calculated for each month, for different habitats and UAP of a particular habitat for 12 months was pooled together and the average was taken as the UAP for that particular habitat and summarized in Table 16.

TABLE 16. OVERALL UAP OF DIFFERENT BREEDING HABITATS DURING 1981

Type of habitat	UAP
Cesspit	25
Cesspool	3
L- Drain	1
U- Drain	15
Kutcha Drain	3
Canal	6
Well	14

The UAP, an indicator of mosquito productivity of particular habitat was multiplied by the total area of same habitat available for breeding in the locality, to derive an estimate of total pupal production from that locality, which was termed as BPL (Breeding Potential of the Locality). The 60 localities were ranked according to BPL (Table 17).

In cement lined drains water generally flows more freely, therefore, is not generally conducive for breeding. However, the UAP in cement lined drains (U drains) was found to be higher than that of the unlined kutcha drains. A similar observation was also made in Rangoon. This is because kutcha drains are formed along natural gradients without human interference, whereas man made cement lined drains in many towns are not constructed with proper gradient. The L-drain, another type of cement lined drain, though subjected to similar limitation has a lower UAP. This is easily explained by the reason that U-drains are susceptible to clogging due to indiscriminate dumping of the garbage by the public, which in turn enhances the breeding potential. Further, though water flowing in both cement lined drains and kutcha drains is polluted, the degree of pollution in kutcha drains is less due to sedimentation and utilization of organic matter by the microfauna present in the soil in unlined drains.

The contribution of different habitats to mosquito production varies and the percentage of each is shown in Table 18 along with the percentage of surface area of each habitat. Though cesspools contribute for a large area than the U-drains, the percentage of mosquito production from cesspool is much less than U-drains. It is evident from the Table 18 that U-drains which constitute 12.24% of total breeding surface area, contributes about 38% of total mosquito production. Similarly cesspits constituting 2% of total breeding surface area contribute 10% mosquito emergence. Thus controlling mosquito production in U-drains and cesspits (14.4% surface) can prevent 48% emergence. Thus it was planned to prevent mosquito breeding in cesspits by chemical larviciding and drains by cleaning and spraying.

It was also realized that spraying large areas of cesspool for preventing 30% emergence will not be cost effective. Hence biological and other environmental methods were used. Elimination of these habitats were also attempted through intersectoral collaboration and community participation.

TABLE 17. LOCALITIES OF THE STUDY AREA RANKED ACCORDING TO BREEDING POTENTIAL

LEZ	Number of pupae emerging daily from different habitats								Locality
	Cesspit	Cesspool	L-Drain	U-Drain	K-Drain	Wells	Canals	Total	
59	0	0	0	0	0	0	0	0	Victoria Nagar
19	38	0	0	0	0	0	0	38	Jeevanandapuram
20	0	0	19	0	153	0	0	172	Pakkamudayanpet
17	122	315	0	0	150	0	0	587	Kumarakurupallam
10	669	0	36	0	20	217	0	942	Rajaji Nagar
48	487	75	164	0	240	260	0	1226	Mettupalayam
35	197	360	15	0	150	562	0	1284	Uppalam I
47	562	377	138	0	300	163	0	1540	Sokkanathanpet
11	1048	209	147	0	38	119	0	1561	Tagore Nagar
54	373	624	555	0	30	0	0	1582	Veemagoundanpalayam
13	500	266	134	0	206	535	0	1641	Thattotukalapet
52	124	100	144	735	60	511	0	1674	Pavalakaranchavadi
56	964	214	72	0	239	570	0	2059	Nainarmondapam
49	953	150	588	0	429	81	0	2201	Subbaiah Nagar
36	488	210	0	1793	0	0	0	2491	Uppalam II
53	86	2400	225	0	38	0	0	2749	Kamban Nagar
55	120	2994	0	0	149	0	0	3263	Velrayanpet
29	277	80	101	1050	487	1332	0	3327	Ellapillaichavadi
41	589	168	813	1620	360	286	0	3836	Kolas Nagar

TABLE 17 (Continued)

LEZ	Number of pupae emerging daily from different habitats								Locality
	Cesspit	Cesspools	L-Drain	U-Drain	K-Drain	Wells	Canals	Total	
46	912	1699	576	0	1080	110	0	4377	Kadirkamam
9	340	809	68	2808	0	693	0	4718	Pethuchettipet
57	1084	417	0	1665	180	1562	0	4908	Murungapakkam
37	1993	654	39	0	1395	1004	0	5085	Keerapalayam
58	752	272	246	2048	46	1918	0	5282	Kombakkam
60	838	84	77	4560	138	0	0	5697	Ariankuppam
31	116	0	0	5625	0	0	0	5741	K.C. Nagar
43	4331	0	0	2025	135	0	0	6491	Jipmer
1	0	0	3606	0	0	0	2895	6501	Bouleward I
50	982	881	1480	274	153	2767	0	6537	Ozhukarai
38	528	1052	0	0	3150	1949	0	6679	Natesan Nagar
39	1896	1841	871	1890	60	904	0	7462	Thengathittu
7	1164	533	0	0	0	6259	0	7956	Kottakuppam
14	911	780	317	173	246	1503	4590	8520	Saram
27	1131	6391	12	0	1224	0	0	8758	Pettianchatiram
16	1048	6869	0	0	1200	0	0	9117	Rainbow Nagar
12	1049	1845	1404	4035	234	683	0	9250	Lawspet
51	894	2713	188	3150	557	2396	0	9898	Reddiarpalayam
15	1524	2725	220	4716	33	761	0	9979	Brindavan
34	905	74	147	9675	0	0	0	10801	Mudaliarpet II
21	754	6655	163	3375	134	56	0	11137	Illango Nagar

TABLE 17 (Continued)

LEZ	Number of pupae emerging daily from different habitats								Locality
	Cesspit	Cesspool	L-Drain	U-Drain	K-Drain	Wells	Canals	Total	
22	284	1309	0	9900	103	0	0	11596	Kennedy Nagar
24	233	5697	57	4050	122	98	1758	12015	Iyanar Nagar
26	335	11931	222	0	153	0	0	12641	Satya Nagar
28	559	11278	197	0	716	69	0	12819	Mohan Nagar
30	2086	279	487	9261	673	866	0	13652	Govindasalai
45	175	2738	1447	8565	686	241	0	13852	Delarspet
44	323	0	0	8970	135	0	4440	13868	Indira Nagar
3	317	0	0	0	0	687	13200	14204	Kurichikuppam
42	1800	2052	0	6938	96	692	2733	14311	Vambakeerapalayam
4	1784	1198	0	10200	536	998	0	14716	Valakulam
8	431	351	120	10038	2453	1702	0	15095	Karuvadikuppam
5	2082	960	246	7688	285	6143	0	17404	Muthialpet
40	3028	840	69	7440	3677	2605	0	17659	Vanarapet
32	2698	408	1321	10425	130	2744	0	17726	Nellithope
6	1064	15379	0	0	570	996	0	18009	VOC Nagar
25	1060	4109	2243	8429	2358	2435	0	20634	Kosapalayam
23	1104	10344	172	11025	282	1037	0	23964	Orleanpet
33	2541	441	1773	22953	0	4569	0	32277	Mudaliarpet I
18	527	37191	886	0	2389	111	0	41104	Venkata Nagar
2	548	0	8228	43868	0	15290	540	68474	Bouleward II

TABLE 18. RELATIVE CONTRIBUTION OF DIFFERENT BREEDING HABITATS FOR MOSQUITO PRODUCTION IN PONDICHERRY

HABITATS	AREA UNDER			
	NFCP		VCRC	
	% area	% of Mosquitoes	% area	% of Mosquitoes
Cesspits	0.96	4.34	2.10	10.68
Cesspools	21.96	11.49	49.70	30.34
L - Drains	43.86	7.92	19.93	4.06
U - Drains	15.95	43.23	12.24	37.36
Kutcha Drains	1.84	1.00	9.98	6.09
Canals	6.21	6.73	3.53	4.31
Wells	10.00	25.30	2.51	7.16
TOTAL	100.01	100.01	100.00	100.00

5. IMPLEMENTATION OF INTEGRATED VECTOR MANAGEMENT STRATEGY

Following the plan as detailed under section 4, the programme was implemented for five years and described below:

5.1. Intersectoral collaboration for Filariasis Vector Control in theory and practice:

The importance of Intersectoral collaboration in IVM programme has been emphasized in section 3, and this formed an integral part of the strategy by VCRC and is aimed at involving different departments of the state government. This is because various departments of the Government plan and implement their developmental programmes in isolation without integrating their activities and as a result mosquitogenic conditions are enhanced. The different departments which can play a meaningful role in urban filariasis vector control are:

1. Public Works Department (PWD)
2. Town and Country Planning Department (TCPD)
3. Local Administration Department (LAD)
   a) Pondicherry Municipality
   b) Ozhukarai Commune Panchayat
4. Law Department
5. Revenue Department
6. Housing Board and Housing Society
7. Survey Department
8. Information Department
9. Bureau of Health Education
10. Central board for Prevention and Control of Water pollution
11. Agriculture Department
12. Animal Husbandry Department
13. Electricity Department
14. Posts and Telegraphs
15. Department of Industries

The role of these departments in preventing mosquitogenic condition is depicted in Fig.35. The major role has to be played by four departments i.e., PWD, TCPD, LAD, (Municipality and Commune Panchayats) and Law and Revenue Departments. However, the activities of these departments creates mosquitogenic conditions. For instance, one of the important breeding habitat is the low lying areas (Vacant plot/Cesspool) which receive sullage and sewerage from the neighbouring houses. In the town expansions numerous such breeding habitats are a common feature. This is mainly due to non implementation of Town and Country Planning Act.

The concept of town planning was well conceived and executed in zone I and II which is reflected by parallel and perpendicular roads, and good drainage facilities. Zone I within Boulward stands testimony to the strict enforcement of norms even two decades back.

In 1969, the Government of Pondicherry enacted a comprehensive law which contained a provision for declaration of planning area, appointment of planning authorities, preparation of land use map and registers, preparation of interim and comprehensive development plans for ensuring proper and harmonious development, collection of development charges, power to stop unauthorized development and framing building bye-laws, and their enforcement. Unfortunately all unplanned development took place after the decision was taken in 1969 to prevent unplanned development.

Under section 37 of the Pondicherry Town and Country Planning Act read with 61, 62, 63 and 64 of the rules framed under, there are detailed instructions regarding granting permission for development of residential areas. Under the provisions of this act when a promoter, normally owner of agriculture land trying to convert it into residential area, seeks approval for a lay out, the lay out has to be examined with reference to the following points.

(i) Whether any portion of land included in the layout belongs to Government or local body. A reference should be made to the Revenue Department, Municipality and Survey Department to ascertain whether any acquisition is contemplated (which is under law department).

(ii) Whether any levelling is required, if so, the height to which levelling of the entire area

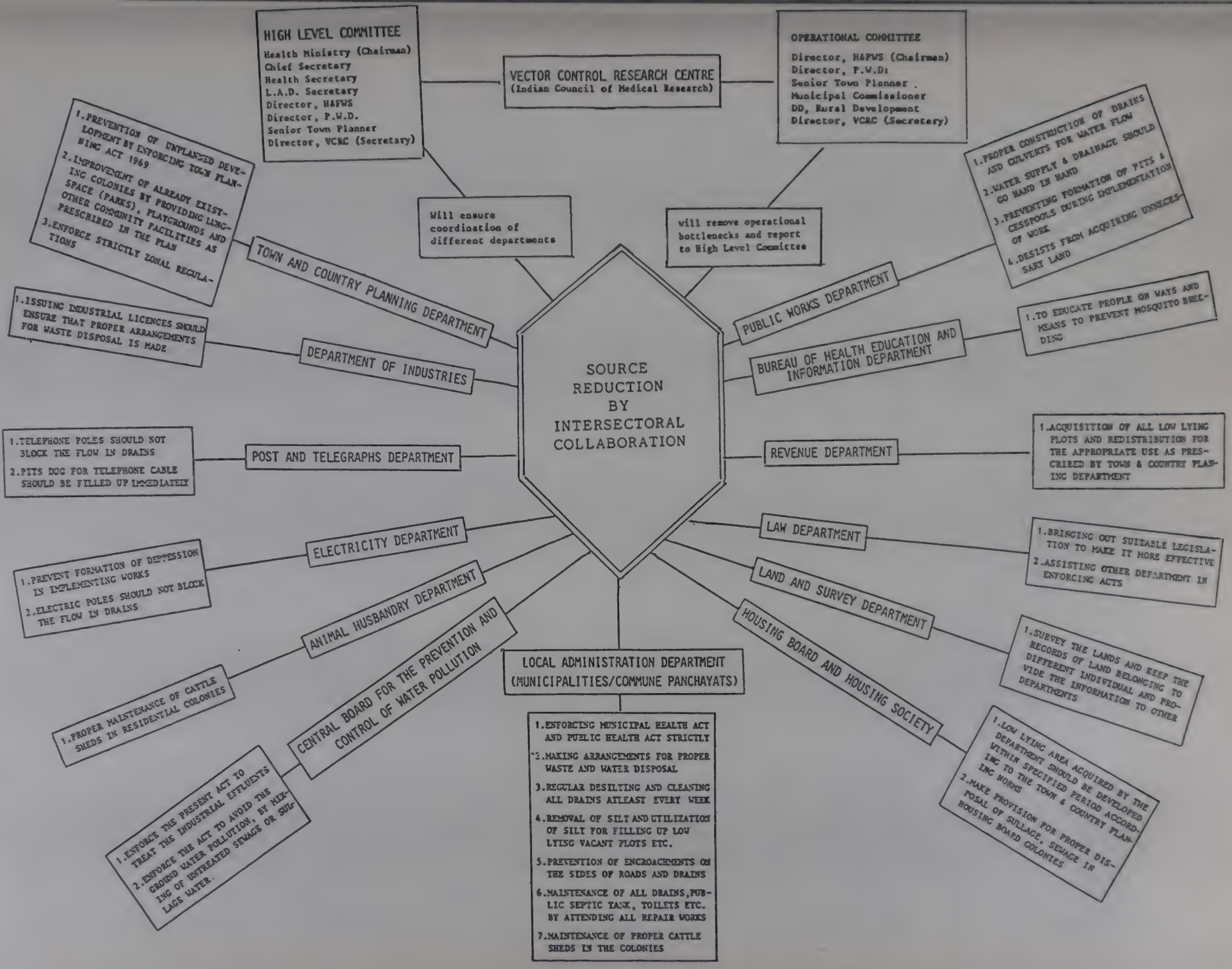

HIGH LEVEL COMMITTEE
Health Ministry (Chairman)
Chief Secretary
Health Secretary
L.A.D. Secretary
Director, H&FWS
Director, P.W.D.
Senior Town Planner
Director, VCRC (Secretary)
VECTOR CONTROL RESEARCH CENTRE
(Indian Council of Medical Research)
OPERATIONAL COMMITTEE
Director, H&FWS (Chairman)
Director, P.W.D:
Senior Town Planner .
Municipal Commissioner
DD, Rural Development
Director, VCRC (Secretary)
Will ensure coordination of different departments
will remove operational bottlenecks and report to High Level Committee
1.PREVENTION OF UNPLANNED DEVELOPMENT BY ENFORCING TOWN PLANNING ACT 1969
2.IMPROVEMENT OF ALREADY EXISTING COLONIES BY PROVIDING LUNG-SPACE (PARKS), PLAYGROUNDS AND OTHER COMMUNITY FACILITIES AS PRESCRIBED IN THE PLAN
3.ENFORCE STRICTLY ZONAL REGULATIONS
TOWN AND COUNTRY PLANNING DEPARTMENT
1.ISSUING INDUSTRIAL LICENCES SHOULD ENSURE THAT PROPER ARRANGEMENTS FOR WASTE DISPOSAL IS MADE
DEPARTMENT OF INDUSTRIES
1.TELEPHONE POLES SHOULD NOT BLOCK THE FLOW IN DRAINS
2.PITS DUG FOR TELEPHONE CABLE SHOULD BE FILLED UP IMMEDIATELY
POST AND TELEGRAPHS DEPARTMENT
1.PREVENT FORMATION OF DEPRESSION IN IMPLEMENTING WORKS
2.ELECTRIC POLES SHOULD NOT BLOCK THE FLOW IN DRAINS
ELECTRICITY DEPARTMENT
1.PROPER MAINTENANCE OF CATTLE SHEDS IN RESIDENTIAL COLONIES
ANIMAL HUSBANDRY DEPARTMENT
1.ENFORCE THE PRESENT ACT TO TREAT THE INDUSTRIAL EFFLUENTS
2.ENFORCE THE ACT TO AVOID THE GROUND WATER POLLUTION, BY MIXING OF UNTREATED SEWAGE OR SULLAGE WATER.
CENTRAL BOARD FOR THE PREVENTION AND CONTROL OF WATER POLLUTION
SOURCE REDUCTION BY INTERSECTORAL COLLABORATION
LOCAL ADMINISTRATION DEPARTMENT (MUNICIPALITIES/COMMUNE PANCHAYATS)
1.ENFORCING MUNICIPAL HEALTH ACT AND PUBLIC HEALTH ACT STRICTLY
2.MAKING ARRANGEMENTS FOR PROPER WASTE AND WATER DISPOSAL
3.REGULAR DESILTING AND CLEANING ALL DRAINS ATLEAST EVERY WEEK
4.REMOVAL OF SILT AND UTILIZATION OF SILT FOR FILLING UP LOW LYING VACANT PLOTS ETC.
5.PREVENTION OF ENCROACHMENTS ON THE SIDES OF ROADS AND DRAINS
6.MAINTENANCE OF ALL DRAINS, PUBLIC SEPTIC TANK, TOILETS ETC. BY ATTENDING ALL REPAIR WORKS
7.MAINTENANCE OF PROPER CATTLE SHEDS IN THE COLONIES
PUBLIC WORKS DEPARTMENT
1.PROPER CONSTRUCTION OF DRAINS AND CULVERTS FOR WATER FLOW
2.WATER SUPPLY & DRAINAGE SHOULD GO HAND IN HAND
3.PREVENTING FORMATION OF PITS & CESSPOOLS DURING IMPLEMENTATION OF WORK
4.DESISTS FROM ACQUIRING UNNECESSARY LAND
BUREAU OF HEALTH EDUCATION AND INFORMATION DEPARTMENT
1.TO EDUCATE PEOPLE ON WAYS AND MEANS TO PREVENT MOSQUITO BREEDING
REVENUE DEPARTMENT
1.ACQUISITION OF ALL LOW LYING PLOTS AND REDISTRIBUTION FOR THE APPROPRIATE USE AS PRESCRIBED BY TOWN & COUNTRY PLANNING DEPARTMENT
LAW DEPARTMENT
1.BRINGING OUT SUITABLE LEGISLATION TO MAKE IT MORE EFFECTIVE
2.ASSISTING OTHER DEPARTMENT IN ENFORCING ACTS
LAND AND SURVEY DEPARTMENT
1.SURVEY THE LANDS AND KEEP THE RECORDS OF LAND BELONGING TO DIFFERENT INDIVIDUAL AND PROVIDE THE INFORMATION TO OTHER DEPARTMENTS
HOUSING BOARD AND HOUSING SOCIETY
1.LOW LYING AREA ACQUIRED BY THE DEPARTMENT SHOULD BE DEVELOPED WITHIN SPECIFIED PERIOD ACCORDING TO THE TOWN & COUNTRY PLANNING NORMS
2.MAKE PROVISION FOR PROPER DISPOSAL OF SULLAGE, SEWAGE IN HOUSING BOARD COLONIES

FIGURE 35. SCHEMATIC REPRESENTATION OF STEPS TO BE TAKEN BY VARIOUS DEPARTMENTS FOR SOURCE REDUCTION

should be done. This is to ensure that there would be no water stagnation in the vacant plots.

(iii) Whether there is an external drain to connect the internal drains or any other arrangement is required. If so, whether promoter has made these arrangements.

(iv) Whether the money required towards provision of drainage has been deposited.

(v) Whether provisions for roads, parks, play grounds etc, were made.

In addition, technical norms of town planning, building and zoning regulations are also to be imposed by the planning authority. After the promoter has fulfilled all these conditions, then only the lay out can be approved. Subsequently individual building plan has to be approved.

Though according to the existing rules there should not be any unplanned development, a number of colonies actually came up in the Pondicherry study area without following the prescribed norms (Table 19). During last twenty years layouts were approved in one or two cases only but the conditions imposed were so vague that the objectives of the act were nullified.

There are many layouts which are not even approved but where individual building plans have been approved. In some cases none of the prescribed conditions were enforced. As a result there are colonies which have no roads or drains (Fig.36). There are colonies where the promoter has shown certain portion as provision for parks and roads in the layout plan but has either sold them out or refused to hand over the same to the concerned civic bodies. In most of these colonies the promoter has not raised the level of the site. On account of low lying nature of the sites, water stagnates, creating mosquitogenic condition. In some colonies the floor of the building is at a level lower than the roads and drains and as a result even where drains are provided sullage water from these houses cannot be disposed off through public drains and therefore is let out into neighbouring vacant plots. All these had given rise to two major difficulties.

(i) Lack of civic amenities in new extensions which are in zones 3,4,5 and 6.

(ii) Though the problems are created by the apathetic attitude and negligence of Town and Country Planning Department the public blame Municipalities and Health Department for this state of affair.

People who have constructed houses with or without approval of the Town Planning Department have been urging the local bodies for civic amenities which could not be provided immediately due to financial constraints. It has been roughly estimated that it will cost nearly Rs. 200,000 (US $20,000) to raise the ground level for laying a road of 1km. length. The expenditure on soling, metalling and surface dressing would cost another Rs. 100,000 (US $10,000). In addition, drains, water supply and street light have to be provided.

Besides there are some legal problems since a few promoters are not even willing to hand over the sites earmarked for roads and drains to the civic bodies, which have to acquire the land after paying huge compensation. The process is time consuming, capital incentive and difficult to be carried out by the local administration, because land has to be acquired by revenue department and compensation value has to be fixed by the PWD after giving appropriate notice. In normal course such procedure takes 5–10 years, but if the owner goes to court the land can never be acquired. Other alternative is to either compel the owner to fill up the plots and/or the Municipality should fill up and recover the cost from the owners. Legal experts are of the opinion that it would be difficult to prove the liability of the owner to fill up low lying plots as the layout has not been approved but building permits have been issued in unapproved layouts. Further, approval for layout and building plans are given by Town and Country Planning Department and Municipality cannot come into the picture at this stage only for initiating penal action against defaulters. The local bodies feel that even if such action is permissible, it will be beyond the capacity of any local body to issue notices to thousands of people to fill up the vacant plots, follow it up, fill them up and recover the cost. The local bodies may not have funds to fill up the plots particularly when recovery is a problem. It has been stated that due to delay in finalization of master plan and enforcement of the provisions, a vacuum was created and unscrupulous pro-

Colonies without proper roads and drains.

TABLE 19. NO. OF COLONIES DEVELOPED DURING DIFFERENT YEARS WITH OR WITHOUT APPROVAL OF TOWN AND COUNTRY PLANNING DEPARTMENT.

Year	Number of Colonies		Low lying area Square Metre	Length of drains required in metre
Before 1971	Approved	17	8,640	7,274
	Unapproved	16	1,47,744	10,274
1971-1980	Approved	24	56,376	23,192
	Unapproved	65	1,88,488	46,686
1981	Approved	3	5,400	1,960
	Unapproved	4	36,072	2,400
1982	Approved	1	1,08,000	NIL
	Unapproved	2	8,640	690
1983	Approved	5	-	-
	Unapproved	3	6.349	1,350
1984	Approved	7	-	-
	Unapproved	Nil	-	-
1985	Approved	9	-	-
	Unapproved	Nil	-	-

moters have exploited the situation fully with the tacit support of politicians. The damage that has already been done in the planning area is almost total.

In Pondicherry, drains are constructed either by the Municipalities or the Irrigation and Road Divisions of PWD. The Municipality provides drains in new colonies located within the municipal area. The Road Division of the PWD provides road side drains and the Irrigation Division constructs storm water canals. Each of these agencies follow different standards and specifications and therefore, construct drains of different designs and in a piecemeal manner and rarely with proper gradient. Ultimately the effluents from all the drains so constructed have to be channelized to the final disposal point which in Pondicherry is the sea. But in Pondicherry, the municipal drains end up in low lying areas or vacant housing plots. The road side drains constructed by the PWD are never completed up to the outfall point and thus remain blocked at intervals and end up as long trenches with stagnant water. The drain construction does not follow any logical pattern and does not fit in with the drainage master plan.

The size of the drains are disproportionate and where a small drain can solve the problem, a huge drain is constructed. The canals constructed by irrigation division meant for draining storm water are without the cunette and as a result sullage water flow slowly during summer months facilitating mosquito breeding. It is worth mentioning that the two major canals constructed during French regime had cunnettes. The proportion of cement and sand hardly follows prescribed norms and varies according to the contractor who strikes a deal with the officials, for mutual benefit.

These drains cross many roads and to maintain water flow it is necessary that construction of culvert should also be carried out simultaneously. But the construction of culverts is done independently and at a very late stage and because of which drains remained as trenches for years together. This un-coordinated constructions facilitates breeding of *Cx. quinquefasciatus* in most of the drains.

Unused lands on the sides of roads, canals, along the banks of the river etc., belong to Government and commonly known as "Poromboke" land. The tendency of Government to acquire land in excess has led to improper utilization of these. As a result land remains undeveloped and water stagnation in these support *Cx. quinquefasciatus* breeding. A little forethought on the exact requirement of land would not have created this situation.

People living in semi-urbanized areas continue their old practices such as keeping cattle. Whereas in a rural situation this does not pose a problem, in urban/semi-urban areas it does so because waste material could not be disposed of properly. In an urban situation these waste material accumulate and find their way to drains thereby creating favourable mosquito breeding conditions. The Animal Husbandry Department encourages cattle keeping by providing incentives but without ensuring proper arrangements for disposal of waste. The overall problem has become so acute that it is beyond the resources of Health Department to control vector breeding. Therefore, in the present programme attempts were made to solve the problem by coordinating the activity of different departments.

Action taken to achieve Intersectoral Collaboration

The HLC was supposed to meet once in every three months and the OC met once in a month. In addition to these two committees another Sub-Committee (SC) chaired either by Health Secretary or LAD Secretary was also started to coordinate the activities from September 1983. Besides routine and regular meetings, coordination of activities was also sought through personal discussions, joint inspection of sites and the effectiveness of such methods is dealt herewith.

Since the beginning of the project in 1981 the VCRC has drawn the attention of the officials of different departments to the problem of mosquitogenic conditions. Specific instances were brought to the notice of the officials concerned during HLC, OC & SC meetings and during joint inspection of sites by VCRC and Government officials. (Fig.37).

The progress was reviewed from time to time and while appreciating the achievements, efforts

Dr. G. S. Jaiya, IAS, Secretary to Govt. of Pondicherry in charge of Public Works, Town and Country Planning and Local Administration Departments making site visits to assess the progress of works undertaken by Government of Pondicherry for environmental improvement.

were made to keep the continuity of the action even after withdrawal of VCRC from control operation. Therefore, from the fourth year of VCRC operations, in addition to pointing out defects, action was initiated in the following direction so that local Governmental agencies should be able to carryout the function without any assistance from outside.

The Departments which should maintain the programme were identified. (i) Linkage developed between VCRC and the departments who will monitor the programme (ii) Training was imparted to the people implementing various projects.

Results and Discussions

Number of times various committees met during the project period were summarized in Table 20.

Table 20 Number of Times Various Committees met and Joint Inspections made during Project Period

Year	High level committee	Operational committee	Joint inspection	Sub-committee	Press	Total
(June–Dec.)						
1980	2	2	2	Nil	1	7
1981	2	4	9	Nil	—	15
1982	4	Nil	6	Nil	—	10
1983	3	Nil	11	2	—	16
1984	5	Nil	5	4	—	14
1985	Nil	Nil	2	3	—	5
Total	16	6	35	9	1	67

In these meetings many decisions were taken and some of the decisions which have a direct bearing on mosquito control are detailed below:

(i) As described earlier non implementation of Town and Country Planning Act of 1969 (No.13 of 1970) led to unplanned and haphazard development. While the damage done over the years could not be rectified overnight it was felt that at least further unplanned development could be prevented. Due to continuous follow up actions, the Lt. Governor, in consultation with the Town and Country Planning Department approved the comprehensive development plan for Pondicherry.

As a result unplanned development of colonies was completely stopped since 1984 and the new colonies are coming up with facilities like roads, drainage, parks and playgrounds.

(ii) Prior to launching of this project all developmental activities were planned by one department (TCPD) and implemented by another (PWD) and handed over to a third department (Municipalities) for maintenance. Since the implementation of work is tardy, maintaining agencies were unable to do much to rectify the situation. Therefore, it was suggested that all the departments responsible for planning, implementation and maintenance work of drains and water supply should be under one secretary. *On the recommendation of VCRC, Government of Pondicherry placed all the three departments (TCPD, PWD & LAD) under one secretary from September 1984.*

(iii) On the recommendation of VCRC, the Government of Pondicherry took a decision to implement the drainage master plan in a phased

manner, which was prepared many years ago and put in cold storage.

(iv) It was observed that drainage system provided in many newly developed colonies did not serve any purpose as these drains are not connected to any outfall drains. Government of Pondicherry has now instructed the commune panchayat to see that proposal for drainage construction should fulfil the following criteria.

a) The drains in a particular locality or colony should be planned on a comprehensive basis. Piecemeal proposals for part of a locality should not be prepared.

b) The drains should have final disposal facility.

c) All the internal roads should have been fully laid, before drains are proposed.

d) Atleast 80% of the buildings should have been constructed in the area where side drains are proposed.

e) The reports accompanying the proposal should contain the information about the fulfillment of the above conditions.

(v) It was observed that many drains are not constructed properly and drains were covered without removing building material and debris. The Chief Secretary, emphasized that the construction material should be removed before covering the drains and proper gradient should be maintained so that scope for mosquito breeding is diminished. *The concerned engineers agreed that in future these points will be taken into consideration while constructing drains, storm water canals, etc.*

(vi) It was also realized that due to the delay and incomplete construction of drains, mosquitogenic conditions were created in Pondicherry. Therefore, the Government has now constituted a committee consisting of the Director, Local Administration Department, an Executive Engineer from Public Works Department and the Municipal Health Officer, to keep an eye on all drain constructions and would take steps to complete the same within the specified period.

(vii) There was no permanent machinery to look after maintenance work and adhoc remedial measures were undertaken to solve the problems of insanitary conditions only when they were referred either by VCRC or by the Public. Since VCRC was to hand over the project to the Government of Pondicherry in 1986, it was decided that the Special Officer of the Municipalities should prepare a complete list of functions performed by the Municipality and draw up a specific plan of action to remedy the defects by having regular inspection of sites and taking action on the spot.

(viii) The quality of construction and maintenance of the public latrines in Pondicherry are far from satisfactory. It was decided that the engineers concerned should strictly follow the guidelines provided by the Ministry of Housing for their construction and maintenance. It was also decided that there should be a system of regular monitoring. The engineering cell of Municipality, the commissioner and the Special Officer were instructed to prepare a schedule for regular inspection in a systematic manner.

(ix) A committee was constituted in February 1985 with a view to ensure the proper implementation and closer coordination of various programmes regarding sanitation, water supply and street lights etc.

(x) Government of Pondicherry also constituted a committee in January 1985 under the Chairmanship of Chief Secretary for prevention and control of problems relating to environmental degradation. To achieve public participation, members of the public were also included in the committee.

(xi) A decision was taken to enforce the provisions of the Municipal Act of 1973 till a new Public Health Act comes into force.

(xii) An underground sewerage system was implemented for zone 1 which is grossly underutilized. A decision was taken to utilize the system to its full capacity.

These decisions if implemented will help in the long run to prevent mosquitogenic conditions. In addition, decisions were also taken to rectify the specific cases of mosquitogenic condition which were reported to Government in different forums by the VCRC. Most of the recommendations were accepted and financial sanction given readily for the work.

Support to the mosquito control programme was achieved in Union Territory of Pondicherry because the high echleons of administration are concentrated in one place and are easily approachable. Altogether 127 specific cases of mosquitogenic condition were brought to the notice of the Government for which recommendations were made and accepted by the Government. However only 20 recommendations were fully implemented, 81 partially implemented and 26 not implemented at all.

Out of the 20 recommendations fully implemented by different agencies 18(90%)solved the problem permanently. However, in one case the problem was partially solved and in another the problem was aggravated.

Out of 127 specific problems referred 81 related to desilting, deweeding, cleaning, filling low lying areas or minor engineering work. The solution to these problems did not require any additional funds and required proper utilization of existing resources (man and material). VCRC emphasized that desilting and deweeding work should be done systematically and the silt removed could be used for filling up low lying areas. The Government of Pondicherry intensified desilting and deweeding work but could not solve the problem satisfactorily due to lack of logistic facilities. As a result, the silt removed from the drains fell back into the drains whereas it could have been utilized elsewhere for filling up low lying areas.

In all, 26 recommendations were not implemented at all. All these were related to eviction of encroachment, enforcing public health act for better maintenance of cattle sheds and maintenance and utilization of buildings constructed for public by the Government. These are the major problems which could not be solved due to political interference.

Inspite of best administrative and financial support (Table 21) of the Government, the results are not commensurate with the money spent. This is mainly due to delayed and faulty implementation of works and in certain cases due to non implementation of the recommendation. The factors responsible for such situations were analysed and described below.

Even when the proposal was approved and financial sanction given the implementation of work is far from satisfactory. Though many people are involved on paper, the actual work is carried out only by one contractor, and supervised by a group of people in a hierarchial pattern. And each one is so busy in technicalities and trivialities that they forget the main objective for which the project was undertaken. Technical feasibility is rarely considered in construction of drains.

i) Even when responsibility is clearly delegated every one including the contractor pass the buck to others.

ii) Eventhough the officials are aware of the problems, due to vested interest at different levels, either there is no implementation or the implementation is faulty. Corruption in construction works is a well known phenomenon in India.

iii) Attitude of the officials also varies from person to person. There are few officials who always cooperate and try to find solution for problems and tried to do something within their means. The other group is completely indifferent and fail to accept that the problem existed at all. Even when they are convinced they prepare a huge estimate to solve the problem inspite of opting for simple solution. People in former group find it difficult to survive and pushed from place to place. The non performer lives happily and enjoys the cut.

iv) Though the engineers are theoretically sound, good engineering practices are rarely seen in construction works.

v) Procedural delays and cumbersome procedures for procuring material and allotment of work.

vi) Dishonesty among the staff implementing the programmes.

vii) Lack of knowledge regarding health aspects of engineering.

viii) Unrealistic estimates prepared by engineers without considering practical difficulties which may arise.

Due to these inherent defects in the system, most of the work implemented with huge financial inputs seldom solved the problem. And when a

TABLE 21. FINANCIAL SUPPORT PROVIDED BY VARIOUS DEPARTMENTS OF GOVERNMENT OF PONDICHERRY DURING THE STUDY PERIOD. (Money spent in Rupees for developmental work by various departments)

Name of the work	1981	1982	1983	1984	1985
By Public Works Department					
1. New Drain Construction	4 52,1000	1 72,000	1,0 98,800	1,6 41,980	5,5 19,520
2. Cementing of Kutcha Drains	1 32,000	1,1 76,500	Nil	Nil	Nil
3. Filling work	1000	10,000	Nil	38,575	Nil
4. Regrading and Repairs	1 00,242	Nil	1 98,000	2 13,295	2,8 31,703
5. Desilting	Nil	65,000	72,000	Nil	Nil
6. Construction of pump house pipeline etc.including maintenance cost	Nil	1 89,000	8 32,000	4 76,888	10 23,650
7. Other works	Nil	81,000	Nil	Nil	97,000
Sub Total	4,75 4,242	1,6 93,500	2,2 00,800	2,3 70,738	9,4 71,873
By Municipalaity					
1. Drainage construction	Nil	1 68,000	Nil	Not available	1 22,233
2. Desilting works	Nil	1 00,000	Nil	Not available	3,1 53,300
3. Other works	Nil	Nil	Nil	Not available	3 08,978
Sub Total	Nil	2 68,000	Nil	-	3,5 84,511
By O.C.P.					
1. New Drainage construction	15,305	Nil	Nil	1 46,719	18,354
2. Drain Cleaning works	2 20,011	2 98,152	Nil	4 62,060	4 39501
3. Filling work	18,405	95,069	Nil	51,574	Nil
4. Regrading & Repairs	Nil	Nil	10,141	5,403	Nil
5. Other works	Nil	Nil	Nil	Nil	49,070
Sub Total	2 53,721	3 93,221	10,141	6 65,756	5 06,925
Grand Total	5,00 7,963	2,3 54,721	2,2 10,941	3,0 36,494	1 3,5 63,309

OCP - Ozhukarai Commune Panchayat

new problem is brought to the notice of the authorities, the concerned official submitted another project to rectify the defects in the construction work.

Vector control is a complex process and costly and can be successful only when people have some sense of urgency and desire. If the problems have to be brought to the notice of an official repeatedly, no vector control work can be sustained. The officials resort to temporary solutions rather than take a permanent remedial measure. In low lying areas every year Government pumps out water during the rainy season by spending large sum of money. But for the last three years our suggestions to take permanent measures to develop the area has received no response.

As a result of VCRC's efforts, activities of different departments were somewhat integrated and many permanent improvements were made. Having achieved good result through ISC it was emphasized that a system should be developed to ensure coordination. The formation of different committees, obviously to solve the problems, actually result in postponing decisions indefinitely. By the end of 1985, the two committees formed by the VCRC also had become non functional. Whatever had been achieved was due to regular intervention of VCRC with different departments.

In most urban situations with the prevailing political, administrative and socio-economic conditions, with very few people performing the job expected of them and with no accountability on the part of officials, urban mosquito control will continue to be a problem.

Developmental activities implemented by different departments without coordinating the efforts usually results in mosquitogenic conditions. But no attempt was made to reverse this trend because mosquito control is not a priority area. As a result, non functional drainage, underutilized sewerage system and open septic tanks continue to produce mosquitoes. The performance is evaluated in terms of physical targets accomplished and money spent. No one is bothered whether it has solved the mosquito problem or not.

Regular cleaning of the drains and providing sanitary services are the functions of Municipalities. However, Municipalities and local bodies are unable to do the same satisfactorily because their resources are limited. The money is also not utilized properly.

The vast majority of the tax payers are ignorant of the fact that sanitation and urban mosquito control are the function of Municipalities to which they pay tax. The people blame Health

"The ramification of the organized life of a great city spread far beyond the factory and covers every aspect of existence. One consequence of importance is the extent to which the increase of organization has brought into existence new position of responsibility and power. Russell refers to this 'Tyranny of Officials' as being one of the worst result of increasing organization and one against which it is of the utmost importance to find safeguard in a scientific society. If not, society will be intolerable to all but an insolent aristocracy of Jacks-in-Office".

—BERTRAND RUSSELL

Department for mosquito nuisance who has no role to play in this matter.

Mosquito control in India is a part of disease control programmes and Health Departments act only when there is an epidemic outbreak or when a VIP complaints of mosquito nuisance.

There is no set up in India exclusively devoted to mosquito control in urban areas like mosquito abatement district in United States. An elected body for mosquito abatement is not practicable in developing countries which are facing a multitude of other problems.

Therefore, urban mosquito hazard can be tackled effectively only if the system is changed by linking mosquito control with sanitation and delinking it from disease control programme.

5.2. Community Participation:

Urban filariasis is an environment related disease and could be easily prevented if people are aware of disease process and play their role in preventing mosquito breeding. Unfortunately in our country disease control is a Governmental programme and community involvement is negligible. This is mainly because the programmes are designed and implemented by governmental agencies without considering local needs and priority of the people. The priorities of common people are food, shelter and clean environment. They get concerned about health programmes only when epidemics of disease take toll of human life. This is evident from the fact that there is a lot of talk of environmental control of mosquitoes during epidemics of Japanese Encephalitis. However, filariasis being a non killer disease neither the people nor the Government makes any concerted effort to control mosquitoes on a permanent basis. Such an approach to disease control is neither cost effective nor sustainable. Therefore in the strategy adopted by VCRC, community participation formed an important and integral part of the programme.

What is community participation? The term 'Community participation' has become the slogan of the decade and innumerable papers have been written and presented in different forums. However, the actual meaning of community participation is lost and left way behind. While each programme emphasizes community participation, none have defined what is really expected from the community. It has been rightly pointed out by the famous malariologist, the late Dr. T. Ramachandra Rao, that community is always participating in the programme by giving financial support as tax without which no programme would have been launched. Therefore, it is necessary to define what sort of participation one expects from the community. Community can contribute by providing additional financial support as it happens in mosquito abatement districts in USA or by providing labour (by doing certain things). The programmes aiming at active involvement of community should attempt answering the following questions before designing and launching the programme.

1. Why Community participation at all?

2. What type of community one is dealing with?

3. What are the causes for non participation?

4. What is expected of community at individual and collective level?

Since the approach to achieve community participation will largely depend on the answers to the above questions an attempt was made by the VCRC to study these factors in relation to filariasis.

Why community participation?

It was observed that mosquitogenic conditions are created by the action or inaction on the part of each and every individual. A few examples given below will prove the point.

Large numbers of low lying vacant plots in unauthorized colonies which are conducive to mosquito breeding are due to flouting of the provisions of the town and country planning act by the people. People do so because they got residential plots at a cheap rate and in the process create mosquitogenic conditions in newly developed layouts.

It is common to find people running unlicensed diaries in residential areas in the heart of the city. There are about 65,000 cows, 6,000 buffaloes, 2,500 sheep and goats and 3,000 pigs. Since there is

no proper waste disposal arrangement, the solid effluents are directed to the nearby drains and block the waterflow in the process. In many areas, rain water collections get polluted with dung and in due course mosquito breeds in them. Such breeding can be easily detected and prevented by people themselves.

In a town of about 300,000 people, since almost everyone is creating mosquitogenic conditions, it would not be feasible to control mosquitoes in many breeding habitats with the present resources. People generally think that they can pollute the environment with organic wastes and the government should clean the place. Therefore, participation of community was sought.

What is the type of community?

From the point of view of public health a community in an urban area is a group of people, who live in a demarcated geographical area and share a common environment. For the present study the residents of a colony is considered as the smallest unit of a community. In India, the urban and rural community have distinct characteristics. In rural areas the interactions between individuals is more marked and a social structure exists. Since most of them are dependent on agriculture there is a lively interaction between the people and the environment.

In contrast, people are highly individualistic in urban areas and they are extremely busy in earning their livelihood. People in the urban area have migrated from different places and as they have not grown together their social interaction is limited. Moreover a sense of belonging to a particular place and concern for development is missing. Thus, in the absence of any social structure people in urban areas are least concerned about their environment. Ultimately the sense of right takes over the sense of responsibility resulting in the belief that the Government is responsible for every thing.

Why community is not participating?

To find out the reasons for the apathetic attitude of the community for the environment, an opinion survey was conducted through a questionnaire. Though the questionnaire designed had some leading questions, the survey gave very useful information about the urban community and they are summarized below:

I) In urban situation social structure is completely lacking and people are individualistic.

II) While standard of personal hygiene is very high, civic sense is very poor.

III) Awareness of mosquito borne diseases is very high only among literates.

IV) Majority of the people also know that mosquitogenic conditions are created by the people.

V) Most of them opined that mosquito control is the responsibilility of Government.

The return of questionnaire also indicated the priority of local people which are:

1) Provision of additional dustbins in their localities.

2) Frequent cleaning of drains.

3) Proper construction of drains.

4) Provision of routine health care at door step.

5) Mosquito control measures.

What is expected from individual members of the community for filariasis control?

In a country like India, people cannot afford to pay more than what they are already paying at present (by way of taxes). Therefore, what the programme expected from the individual was, that his acts of commission and omission should not create any additional mosquitogenic habitats. Every individual of the community was asked to do the following to lessen the mosquito menace.

1) Refrain from throwing solid garbage into the drain, as this blocks water flow.

2) Cattle shed owner should not dispose solid waste materials into the drain.

3) Construction of any kind of structure over the drain which will hamper cleaning and maintenance of drain should be avoided.

4) Screening/hermetical sealing of septic tanks and unused wells should be done by the house holder.

5) Residents should check for container breeding in and around the house and empty them at least once a week.

6) They should not dig any pit which may form permanent breeding source for mosquitoes.

7) They should not meddle with the drains or the covering slabs without consulting concerned authorities.

8) Before constructing house, they must consult and seek advise from the Planning authorities regarding drainage outlets and should strictly follow planning regulations.

9) If they own a low lying plot, they should fill up the same upto the nearest road level.

10) Cooperate with the operational staff and extend all help to serve people.

From the community as a Group:

i) If there are large bodies of water stagnation, the local authorities must be contacted for remedial action.

ii) If the construction of the drain or public latrines are improper leading to mosquito breeding this should be brought to the notice of higher authorities.

iii) If a drinking water pipe line is crossing the drain thereby obstructing flow and enhancing the chance of sullage and drinking water mixing, health authorities should be informed immediately. This is a major health hazard as besides blocking drains, chances of spreading gastrointestinal diseases are also increased.

With this basic information VCRC directed its activities in two directions to enlist community participation. They are

i) Mass public health education to bring a change in their attitude.

ii) To organize the community for self help.

Following actions were taken to bring about a change in the attitude of the people.

a) To create awareness among politicians, the Health Minister, Minister for PWD and Local MLA were taken around the specific problem areas.

b) Training Programme in vector control methods for opinion leaders was conducted in the following localities:

1) Gandhi Nagar, 2) Kosapalayam, 3) Mohan nagar, 4) Nellithope, 5) Rainbow Nagar, 6) Govindasalai, 7) Orleanpet, 8) Mudaliarpet, 9) Natesan Nagar, 10) Subbaiah Nagar, 11) Vivekananda Nagar, 12) Venkata Nagar, 13) Kamaraj Nagar, 14) Kottakuppam, 15) Vanrapet, 16) Kamban Nagar, 17) Uppalam, 18) Kathirkammam, 19) Vambakeerapalayam, 20) Murungapakkam, 21) Thengathittu, 22) Rajavudayar Thottam. A total of 100 opinion leaders were trained.

c) Door to door health education programme was conducted on a continuing basis. More than 100,000 people were contacted individually by various members of our staff to make them aware of the problems during the last 5 years.

d) 6,000 pamphlets depicting the danger of diseases carried by mosquitoes and how to control them were distributed among the people.

e) 9,000 posters in 3 designs were displayed in various parts of the study area.

f) Hoardings: 20 hoardings ($6' \times 4'$) in ten designs were fixed in vantage points. To make them attractive, designs were developed keeping in view the local sentiments and social set up of the people. Since people are religious, some of the hoardings were based on mythological stories.

g) To intensify Health Education Programme the help of following were also sought.

1) National Service Scheme, Tagore Arts College, 2) Youth Forums, Subbaiah nagar, Kathirkammam, 3) Tamizh Ilaignar Manram, Kathirkammam, 3) Tamizh Ilaingar Manram, Thelarshpet. (4) All India Youth Federation, Subbaiah nagar, 5) Bharadidasan Youth Club, Keerapalayam, 6) Y.M.C.A., Pondi-

cherry, 7) Youth wings of all Political Parties, 8) All India Catholic University Federation (AICUF).

h) Health Education Programs were also initiated in the following schools.

1) S.D.A. School, Gandhi nagar, 2) Govt. High School, Kathirkammam, 3) Govt. Higher Secondary School, Muthirapalayam 4) Govt. Primary School, Mudaliarpet, 5) Govt. Primary School, Keerapalayam, 6) Primary School, Nellithope, 7) Primary School, Vanrapet, 8) Primary School, Thengathittu, 9) Primary School, Vambakeerapalayam, 10) Primary School, Murungapakkam, 11) Primary School, Govindasalai, 12) Primary School, Gundupalayam.

i) Advertisement: In a local weekly newspaper, slogans were published regularly for many months about the danger of mosquito nuisance and remedial measures to be taken. Besides many articles and letters to the editor were written in the various news papers.

This programme was continued for five years and evaluation of result showed that the so called "highly" educated people refused to participate in mosquito control programme. While uneducated people were willing to cooperate, the bureaucrats and officials always raised objections which discouraged peoples' participation. The following example will not be out of place.

A plot of approximately 10,000 sq. mt. was proposed for acquisition by the Housing Board. However, some Government officials managed to corner a few plots for their own purpose and after that the Housing Board lost interest in acquiring the land. When VCRC approached the owner he agreed to fill up the land and construct a school. But Government refused permission on flimsy technical grounds. As a result one hectare area with heavy Eichornia growth is supporting heavy mosquito breeding in that area since the beginning of the project. Here is a case where neither Government want to do any thing nor do they allow the owner to develop this land. The people continue to suffer from mosquito nuisance. Community Participation in certain sectors like the posh colonies, where officials and well-to-do people live was not very successful. These residents are literate but refuse to get educated. Since they hold high position of power and enjoy political patronage, they consider the VCRC or the health staff as their personal servants who should come at their beck and call for spraying adulticide in their house. Such people are not prepared to do anything to prevent mosquito breeding within their premises. *While VCRC received full cooperation from the top officials and the economically weaker sections of the society, the middle level officials and the novo rich* continued to be non-cooperative and actually hampered effective programme implementation. Such people can be only tackled with enforcement of stringent public health act, which again could not be implemented due to political interference. It is proved beyond doubt that motivation, Health Education and Community leaders training programme etc. could yield result when dealing with smaller community in rural reas. In urban areas where political interference is common, only a little show of official authority will certainly help.

Many Government officials including a few of the coordination committee members themselves continue to keep cattle in unhygenic condition. One of the members of the high level committee was keeping cattle in the office campus itself. Therefore, when law makers are themselves law breakers very little can be done. These people have no feeling for the suffering of others as they manage to get their houses routinely treated with insecticides. In another area an individual with political clout running a biogas plant refused to take any measure to rectify the defect in construction which has resulted in heavy mosquito breeding.

On the contrary the poor and illiterate people were more cooperative and they were ready to do their bit provided the programme does not interfere with their bread earning capacity. Since they live in the most neglected slums their priorities were for roads, drains, street lights, dustbins, drinking water pipeline etc. VCRC took their cases with concerned authorities for remedial measures but with limited success.

The poor people considered money spent on vector control as a wastage and feel that this could be used for providing houses, etc. There was also a general apathy towards all Governmental pro-

grams because of their disappointment with the performance of Government departments and therefore, do not wish to cooperate. The majority of the people have resigned to their plight of misery and ignorance. Apart from this, there are people with vested interests who want to keep the poor in the same state for their own benefit, since they constitute the biggest vote bank.

To improve living conditions of the people in a slum area, the Govt. agreed to rehabilitate them in a new place but the local legislator concerned did not want his vote bank to be shifted to another constituency. As a result no improvement could be made. Above all abject poverty in the slum area is a great hindrance to any improvement programme.

Active participation of poorer sections of the community in vector control programme was beyond our expectations. Community involvement in filling work is summarized in Table 22. VCRC provided transport for carrying filling material and the community volunteered the labour. Because of continuous interaction with the community an awareness has now been created and many permanent improvements have been made. However, in the urban situation the problem is more due to Governmental inaction. Inspite of changes in awareness and attitude the problem remains more or less the same.

This is mainly due to communication gap between the Government and the people. Government thinks that people have no say in developmental activity and therefore their real needs did not find any place in the developmental plans. For example, in posh localities where each house is having its own toilet, the LAD is constructing public toilets, which is of no use to the local community.

Therefore, VCRC motivated and organized the citizens to take part actively in all community development programmes and reminded them of their basic right to expect good sanitation. Once the people realize this, there would be no difficulty in maintaining a better environment as the people themselves will take over the role of VCRC in checking environmental degradation.

The Local Administration department took a decision to publish through local newspapers all the works to be carried out in different localities so that people can react and help in planning, implementing and evaluating the various programmes. But this decision was never implemented.

What we could not achieve is to stop indiscriminate dumping of material here and there. It is known that old habits die slowly. If this attitude has to be changed, the Government must implement Public Health Act with stringent penal provisions. If this can be done in Singapore it can also be done in Pondicherry.

The VCRC set the stage and developed a system where Government and people can interact for mutual benefit. If the achievements gained cannot be sustained by continuity of effort, the people will continue to suffer. It is hoped that the Government and community will join together in making Pondicherry a mosquito free town. The VCRC has demonstrated that this could be done.

"Planning has increasingly become the prerogative of elite professional and bureaucratic groups which are theoretically accountable to the citizen, but to which individual citizen has little access. More emphases are being placed on design aesthetics, fashion, technological innovation, engineering solutions and functional efficiency than the needs and satisfaction of the users of the planned environment".

—ANONYMOUS

TABLE 22 COMMUNITY INVOLVEMENT IN FILLING UP LOWLYING AREA

Name of the Area	Surface area filled in m^2	No. of Labourers participated	Money spent on transportation Rs. P.
Vambakeerapalayam	96.75	29	257. 00
Saram	52.00	24	175. 00
Raja Nagar	2.00	2	34. 00
Sundaramasthri Street	2.2	4	39. 00
Karuvadikuppam	10.0	9	39. 00
Pillaithottam	8.0	2	32. 00
Thattanchavadi	21.0	14	121. 00
Sathya Nagar	12.0	4	31. 00
TOTAL	203.0	88	728. 00

5.3. VECTOR CONTROL

The integrated vector management strategy laid major emphasis on environmental improvement through intersectoral collaboration and community participation. However, it was anticipated in the beginning itself that the type of support required for mosquito control might not be forthcoming immediately. This is mainly due to the large financial outlay involved and the cumbersome procedures of getting minor engineering works and other improvement done by the concerned departments. Since the project's main objective was to reduce vector density drastically within the shortest possible time, VCRC used appropriate means to control vector density.

The term vector management implies that the vector/vectors will coexist with human population at tolerable levels of abundance, since eradication is not possible. This could be done by a single method or by a combination of several methods. Though it was known that a large number of infective mosquito bites are necessary to give rise to a new case of filariasis, the level at which transmission will cease to occur is not known. Therefore, programme aimed at achieving maximum control through a combination of various methods, which will also provide information on the utility of different methods.

5.3.1. Environmental control:

Eventhough environmental methods are effective and non polluting, they were rarely used for controlling *Cx. quinquefasciatus*. In the past environmental methods were tried mainly against *Aedes* species (Gohel *et al*, 1980, Philen & Carmichael, 1956) and against malaria vector. However, naturalistic and environmental methods of control were given up after the introduction of DDT. The Health Planners laid more reliance on vector control by using powerful insecticides. Though it was stated that direct source reduction and prevention is economical in the long run the planners were reluctant to accept this view due to lack of supportive data on cost effectiveness of such methods.

As already stated *Cx. quinquefasciatus* is the product of mismanaged environment and it is an accepted fact that the growth of vector population could not be checked in a cost effective manner without reducing the breeding surface area. Since the environmental method will not be able to eliminate all breeding habitats, it was supplemented by other methods for effective vector control. Improvement work was undertaken wherever breeding areas could be eliminated with minimum capital expenditure. This was done to reduce maximum area breeding in minimum time and with minimum expenditure. The environmental works carried out to reduce vector population includes.

a) Levelling of low lying areas. (Fig. 38).

b) Bailing out water from large water bodies. (Fig. 39).

c) Cleaning, deweeding, desilting and channelization to increase water flow and to reduce breeding surface area. (Figs. 40 & 41)

d) Impounding water and releasing at regular intervals.

e) Deepening shallow water bodies to reduce vector breeding.

f) Closing of the vent pipe of septic tanks with cloth (Fig. 42) and sealing cracks and crevices.

Environmental work carried out during the project period is discussed below:

i) *Environmental improvement in swampy lagoon:*

It was suggested to the Government that the problem in Dubrayapet and Thengathittu (Section 5.1.) could be solved permanently by (i) draining the sullage water into the sea at a point which is 2.6 kms. away from the present site following the natural gradient and (ii) dredging the whole marshy area and develop it into a lido where fish can be grown. These suggestions were accepted in principle but not implemented by the Government. Since the project is time bound and implementation of permanent measure would take time, the environmental improvement work was undertaken in phased manner by the VCRC.

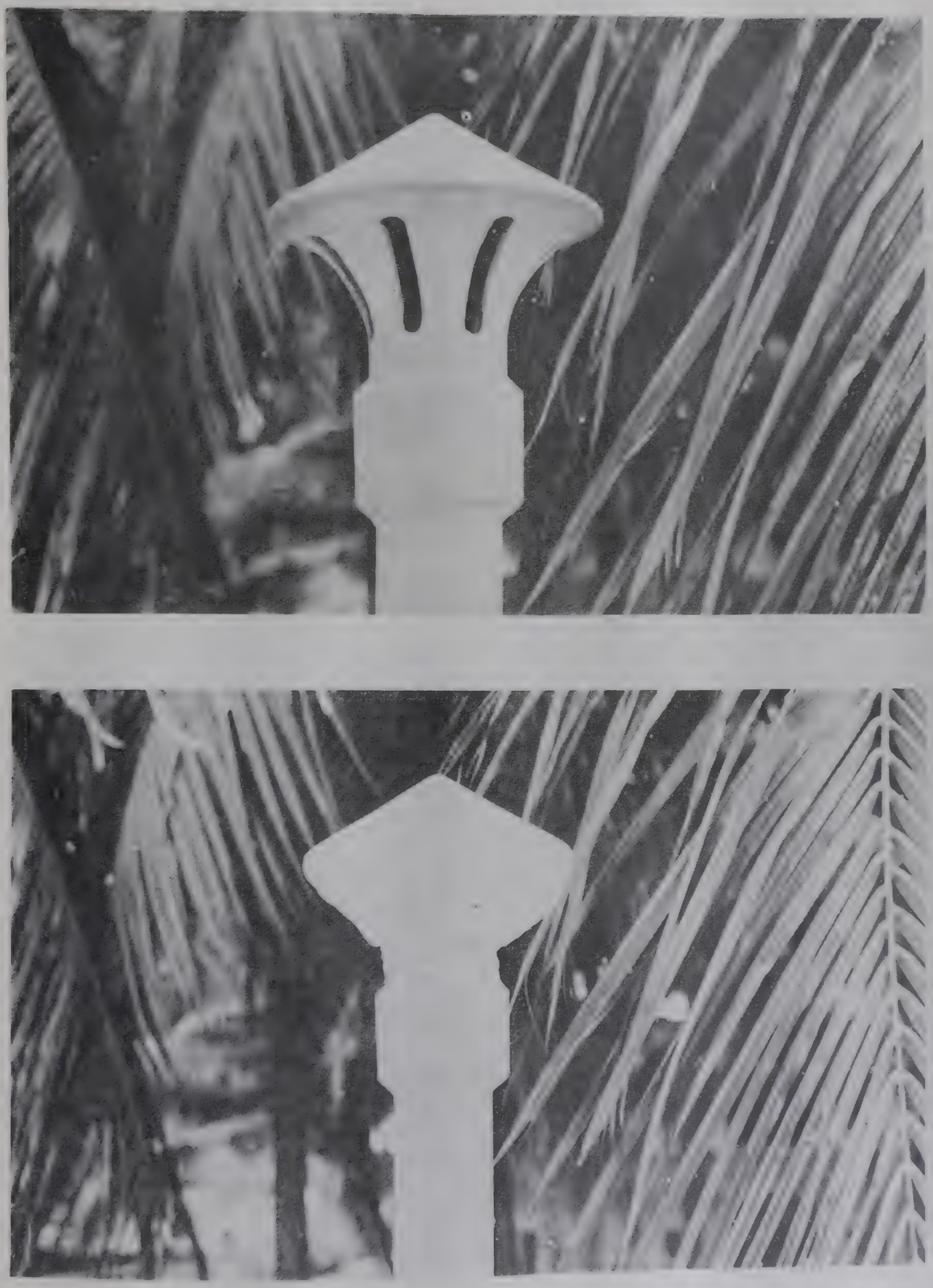
During the first year of the project hundreds of coirpits on the northern side of the joint canal (Uppar and Grand) were filled up with sand from

Levelling of a low lying area.

Bailing out water from a vacant plot.

Cleaning of a 'U' drain in progress.

Deweeding and channelization of a kutcha drain.



Vent pipe of a septic tank open (above) and closed (below).

nearby areas (Fig. 43). Filling up of coirpits in this area resulted in immediate reduction of 7,525 sq. mts. of breeding surface area permanently. The total manpower spent was 664 man days at a cost of Rs. 5,312/- (US $ 531) (Table 23).

Filling work with manual labour was undertaken in the marshy area located on the eastern side (6,020 Sq.mt.) of the joint canal. The filling done manually was found to be not only time consuming but also not cost effective. Therefore a bulldozer was hired from the Agricultural Department and the swampy area on the easternside was closed with sand and the sand bar levelled. Casuarina seedlings were planted in reclaimed area. This prevented mosquito breeding in this area permanantely.

The part of the joint canal (150 × 22 metres) which was not serving any purpose other than supporting profuse mosquito breeding, was converted into a tank by blocking either ends by constructing walls and was used for stocking fish (Fig. 44). The walls were constructed by Public Works Department at a cost of Rs. 6,000 (US $ 600). In this tank mass culturing of *Gambusia affinis* was undertaken and utilised for controlling vector breeding in wells.

The Public Works Department filled up an area of about 2,000 Sq.mts. for the construction of a pumphouse by spending Rs. 4,000 (US $ 400) which was commissioned with two 20 H.P. pumps and the sullage was conducted into the sea by means of a 6" pipeline (Fig. 45). However, the capacity of the pumps was found to be inadequate. Inspite of 24 hours pumping, situation remained unchanged. The total estimated quantity of water brought to the lagoon by two major canals was 36 million litres/day and the average daily pumping capacity of the pumps was only 3.6 million litres/day. The expenditure incurred for construction of pumphouse, installing pumps and laying pipelines was Rs. 185, 000/- (US $ 18, 500). Since 90% of the total discharge was found still accumulating in the lagoon it was decided to drain the excess water by augmenting pumping capacity. The VCRC provided additional funds (Rs. 500,000 (US $ 50,000)) and purchased two 25 HP pumps for Government of Pondicherry to enhance the pumping capacity.

During rainy season excess water in this lagoon was drained into the sea at Veerampattinam through manual labour once in 30 days. The high tides during the fullmoon and newmoon clogged the mouth of the lagoon with sand bars.

Once it was demonstrated by VCRC, Government officials were convinced that the problem could be solved permanently. As a result, PWD Minister ordered the officials to immediately take up the work of extending the canal right upto Veerampattinam along the natural gradient to facilitate flow throughout the year. (This work is still not implemented).

However, during summer months, from Feb-June, maintaining water flow was not possible with mannual labour alone due to low volume of water in the lagoon. Therefore, until permanent measures were undertaken by the Government this area was maintained free from breeding by continuous pumping during summer months and draining the lagoon during rainy season.

Filling:

In addition to the major environmental work carried out at Dubrayapet area, filling work was undertaken in different parts of the study area (Fig. 46). Silt removed from drains and debris left after construction work were used for filling. The utilization of silt and building material also minimized the blockage in drains. The amount of filling work done during different years is summarized in Table 24.

During the project period 3.33 hectares of area was filled up by spending only Rs. 43,931 (US $ 4,393) thereby saving a sum of Rs. 373,010 (US $ 37,301) as cost of recurrent insecticide application. Thus, filling work resulted in net saving of Rs. 329,079 (US $ 32,908).

Filling up of the low lying area, though cost effective and permanent, is not possible in all situations and this method can be used only as a complement to other methods used in Integrated Vector Control. This study also disproves the belief that environmental method is capital incentive. Environmental method like filling can be implemented in the most cost effective manner and without any large capital outlay. It has also been

Coir pits facilitating breeding (above) and eliminated (below).

TABLE 23. NATURE AND BENEFITS OF ENVIRONMENTAL IMPROVEMENT WORK IN DUBRAYAPET SWAMP TO PREVENT VECTOR BREEDING.

Nature of work done	Breeding source reduced (area in m^2)	Expenditure Man power/ Machine	Cost of Insecticide saved per year	Cost of Insecticide saved during the project period	Net saving	Estimated Income Revenue through plantation/fish /selling house plots etc.
		Rs.	Rs.	Rs.	Rs.	Rs.
A. Filling Work						
a) Coirpits on the northern side of canal.	7,525.0	5312.00 (Man power)	20852	83408	78096	6,20,000*
b) Marshy swamp eastern side of the canal	6,020.0	2500.00 (Bulldozer) 800.00 (Man power)	16692	66768	63468	
c) Area on the western side of Grand canal	2,833.0	9473.00 (Man power)	7852	31408	21935	
B. Channelization (Once in six months in a year)	6,000.0 (1.2 km length 0.5 km breadth)	1000.00 (Single time)	16640	66560	61560	
C. Keeping open the mouth at Veerampatinam (3 times in a year)	5 60,000.0	1000.00 (per opening)	1811888	5435664	5423664	40,000,000
D. Water impoundment (Once in a year during post-monsoon)	80,000.0	1200.00 (Single time)	258856	776568	771768	
E. Lido formation for fish culture	3,500.0	4000.00	111336	34008	30008	
F. Conversion of drainage canal into fish culture pond by providing barrier wall	3,300.0	6000.00	10660	31980	25980	15,000
G. Afforestation						
a) Casuarina planted on the marshy land	6,020.0	200.00 (Seedlings) 2928.00 (Man power for six months)				7,000
b) Eucalyptus planted near the pump house area	2,000.0	200.00 (Seedlings)				
c) On the side of the canal	600.0	2928.00 (Man power for six months) watering)				
H. Community park	2,000.0	150.00 (Ornamental plants) 10950.00 (Man power)				
GRAND TOTAL	6,79,798.0	67241.00	2154776	6526364	6476479	

* by selling plots of size 240m^2 each for Rs.20,000.

Part of the joint canal converted into tank for stocking fish.

Pipeline erected to carry sullage to sea.

Filling resulted in permanent reduction of breeding source.

TABLE 24. THE COST AND EXTENT OF BREEDING SOURCE REDUCTION THROUGH FILLING WORK DURING DIFFERENT YEARS.

Year	Cesspits		Cesspools and vacant plots		Coirpits		Cement tanks		K-Drain		U-Drain		U-canals		Wells	
	Surface area reduced (m^2)	Money spent Rs.	Surface area reduced (m^2)	Money spent Rs.	Surface area reduced (m^2)	Money spent Rs.	Surface area reduced (m^2)	Money spent Rs.	Surface area reduced (m^2)	Money spent Rs.	Surface area reduced (m^2)	Money spent Rs.	Surface area reduced (m^2)	Money spent Rs.	Surface area reduced (m^2)	Money spent Rs.
1980	1.11	8.0	2.88	2.5	Nil	-	Nil	-	20.95	48.0	Nil	-	Nil	-	Nil	-
1981	3190.19	3678.75	9731.61	6382	763.04	363	Nil	-	967.4	483.5	14.86	128	Nil	-	4.67	42.0
1982	208.52	292	3142.15	8224	278.81	326	26.37	58	438.45	751	44.61	13	44.19	33.0	243.93	1683
1983	12.27	20	1956.87	4886	Nil	-	34.1	92	1663.5	1898	430.0	130	17.88	43.0	15.93	659
1984	Nil	-	646.05	489	Nil	-	180	130	120	40	Nil	-	4.83	30	57.38	100
1985	Nil	-	2431.54	4661.29	Nil	-	Nil	-	84.52	160.58	53.0	117.2	Nil	-	Nil	-
TOTAL	3412.09	3998.75	17911.1	24644.79	1041.85	689	240.67	280	3294.82	3381.08	542.47	388.2	66.9	106	321.91	2484

observed that the debris and waste building materials either accumulate on the roads or find their way to the drain. If the local bodies use this debris for filling, the cost of filling work could be kept further low. In our experience it was found that the average cost of filling a water body of 30 cm. depth is Rs. 1.32 (US $ 0.13) for one Sq.mt. Whereas to treat one sq.mt. of the same area weekly with fenthion costs approximately Rs. 6 (US $ 0.6) per year including manpower. Thus by spending Rs. 43,931/- (US $ 4,393) on filling work Rs. 329,079/- (US $ 32,908) was saved.

Enviromental improvement in drains:

The basic requirement to prevent mosquito breeding is to increase the surface velocity of the water flow in drains. However, due to excessive deposition of silt and dumping of garbage in drains, water hardly flows in them. The minimum velocity of water required for preventing oviposition was determined by undertaking a field study in Pondicherry. Ten U-shaped drains and five kutcha drains running in different places of Pondicherry were selected for monitoring surface velocity of water, silt deposition and breeding status.

Out of 15 drains selected for the study running to a length of 4.35 kms. only two drains were found to have the maximum surface velocity of 30 cm/sec. and above. It is evident from the data (Table 25) that in other U-drains the surface velocity was found to vary between 6.91 cm/sec. and 16.29 cm/sec. before cleaning and it increased slightly with cleaning and desilting. But in none of the drains the surface velocity could be increased to the required velocity of 30 cm/sec.

Silt deposition rate was also found to be minimum in the two drains when water flow was found to be more than 30 cm/sec. No breeding was observed in such drains, whereas in other drains breeding continued to occur even after cleaning and desilting. In all the five kutcha drains which were monitored regularly the surface velocity was found to be less than 20 cms/sec. before cleaning and the surface velocity could only be slightly increased by cleaning. The silt deposition rate was also found to be very high in these kutcha drains. Breeding status remained unchanged in the kutcha drains even after cleaning. In Pondicherry the surface velocity of the water running in drains is much below the desired level, the reasons for which are described below:

(i) The drains in Pondicherry are constructed with stone and surface being rough, resistance is very high and water flow is minimized. This could be overcome by providing smooth surface.

(ii) The cross sectional area must be maintained to have a greater flow as the water flows with greater velocity in a narrow space rather than in a wider space. In Pondicherry the drains are designed mostly to carry storm water but these drains actually carry only sullage water. As a result during summer months drains become an ideal breeding ground for *Cx. quinquefasciatus*. To prevent such breeding either 'V' shaped drains or drains with cunnettes could be constructed.

(iii) The gradient must be such that the minimum velocity required for water flow must be achieved. At present the drains are being constructed with a gradient varying from 1 in 400 to 1 in 1000. Wherever possible the slope should be increased further to obtain the desired flow rate.

The above conditions required for optimal flow of water were found fulfilled only in two drains where the surface was smoothly lined and the cross sectional area is proportionate to the volume of water flow and the slope was also sufficient. The roads adjacent to these two drains were also metalled and thereby minimum silt deposition occurred in these two drains.

In several other U-drains even though they are smoothly lined, there is no proper flow because these drains end abruptly and are choked with silt and debris. In some U-drains the gradient does not permit the water to flow with the required velocity.

In kutcha drains, the resistance offered by the surface and vegetation is too high to maintain the water flow at required velocity.

It was found that cleaning, desilting etc. alone will not be able to prevent breeding. Therefore, the drains were maintained free from breeding by cleaning, desilting and insecticidal spraying. However, cleaning increased the effectiveness of the spraying operation by exposing the hiding immatures and was appreciated by the community.

TABLE 25. SURFACE VELOCITY OF WATER AND SILT DEPOSITION RATE IN A FEW DRAINS OF PONDICHERRY.

Sl. No.	Name of the drain (Nature)	Length in metres	Surface velocity in cms/sec.					Average velocity after cleaning	Silt deposition rate in cms/day	Breeding status	
			Before cleaning	I Day	II Day	III Day	IV Day			Before cleaning	After cleaning
					after	cleaning				average number of IV instar/dip.	
1.	Balaji Theatre (U)	200	28.48	32.11	31.75	30.34	29.24	30.93	0.33	Nil	Nil
2.	Tagore Arts College (U)	1040	33.24	30.37	33.56	34.05	38.24	34.05	0.43	Nil	Nil
3.	Murungapakkam (U)	200	15.80	18.18	18.58	17.15	17.33	17.81	0.33	Nil	Nil
4.	Mainarmandapam (U)	270	14.02	17.41	16.06	17.35	16.72	16.88	0.47	0.47	0.12
5.	Port Office (U)	200	14.22	12.55	15.84	14.92	17.37	15.17	0.56	Nil	0.02
6.	T.V. Bus Stand (U)	200	16.29	20.91	20.20	18.55	18.10	19.44	0.99	Nil	0.09
7.	Reddiarpalayam (U)	200	16.78	22.18	19.36	20.18	19.21	21.75	0.41	1.95	1.09
8.	Muthirapalayam I (U)	200	10.92	13.19	10.52	14.46	10.93	12.27	1.48	Nil	0.01
9.	Muthirapalayam II (U)	170	12.73	18.34	15.92	15.72	16.61	16.64	0.76	0.02	0.06
10.	Thengathittu (U)	200	6.92	9.32	8.94	8.95	9.77	9.24	0.45	0.60	Nil
11.	Kosapalayam (K)	520	15.62	15.83	14.81	14.99	14.88	15.12	1.55	0.29	0.18
12.	Venkata Nagar (K)	370	18.30	20.06	19.69	19.08	18.55	19.34	2.16	0.04	0.28
13.	Vanarapet (K)	220	19.61	24.25	22.55	19.80	17.70	21.07	0.69	0.43	0.11
14.	Saram (K)	360	16.26	17.42	16.00	17.06	15.29	16.44	1.32	0.21	0.07
15.	Kolas Nagar (K)	200	6.91	7.54	9.93	8.42	8.96	8.71	0.72	0.45	0.49

U – U-shaped puccah drains
K – Kutcha unlined eartnern drains
Average of 10 weeks observations.

Therefore, cleaning, desilting and deweeding work was undertaken routinely (Table. 26).

Channelization:

Though filling is most cost effective in smaller water bodies this is not possible in large cesspools or swamps receiving sullage water continuously or in large drains. Such breeding habitats were channelized to reduce total surface area (Fig. 47). These measures not only reduced breeding surface area but also increased the surface water flow and thereby prevented mosquito breeding (Table 27).

Channelization work was carried out in different areas by spending approximately Rs. 9,000 (US$ 900). However, roaming cattle and pigs nullified the effect of channelization, requiring repeated efforts.

Pumping:

Bailing out water from low lying areas was also found to be cost effective in reducing mosquito breeding. Breeding was prevented in 5.09 hectares by this method. During post monsoon period water was pumped out by spending only Rs. 2,386/ (US $ 239) and as a result the low lying plots dried up and remained free from mosquito breeding during summer months (Table. 28).

Impounding water and flushing as a method of control:

An irrigation channel (in Zone 5) of 1000 metre length was covered with concrete slabs against technical advice. To support the concrete slab covering, cement pillars were erected in the middle of the drain, leaving very small space in the middle for water flow. The houses by the side of the drain diverted their toilet effluents into this drain. Innumerable small shops were constructed over the drain and the people started dumping garbage into the drain. Cleaning or desilting of this drain was not possible manually due to suffocation caused by obnoxious gases. Therefore, water was impounded outside the covered area and allowed to flow once a week. This flushed the drain and breeding was reduced considerably. Initially this drain was flushed with sea water. Flushing with sea water was more effective because flushing not only changed the physical state of water from stagnant to running but also increased salinity of the water.

Flushing the closed drains with sea water was found to be very effective. However, this method was practiced only in rare cases (Table 29), mainly because tankers were not available and the facility for pumping sea water from sea was available only through port department. The municipality, whose job includes sanitation, and who owned the tankers refused to loan them to the VCRC even on payment. However, it is the most cost effective method of mosquito control in closed drains provided Government makes permanent arrangements for pumping sea water and flushing the drain.

The environmental methods are not only cost effective but can also be implemented by least trained staff with simple equipments like shovels and spades. During the five year period, breeding was prevented in 78.3 hectares by various environmental methods in different types of habitats by spending only Rs. 122, 488/- (US $ 12, 249) whereas to control breeding in the area routinely by chemicals would have cost about Rs. 7,401, 072 (US $ 740,107). In addition to saving the cost of insecticides, an estimated amount of 40 million rupees (US $ 4 million) could be fetched if the reclaimed land is utilized for housing. However, the sum of Rs. 521, 167/- (US $ 52, 117) spent on desilting and deweeding was not economical. This method can be useful only when the design and construction of drain are proper.

5.3.2. Chemical control:

Insecticide was used routinely in many breeding habitats (Fig. 48) to bring about drastic reduction in the vector density, and in places where other measures like filling, channelization, impoundment of water etc. could not prevent *Cx. quinquefasciatus* breeding.

Larvicide of choice:

In the present study larvicide was selected on the basis of its efficacy, toxicity to non target organisms, potentiality of delaying of resistance and availability of the compound, and above all, cost. It was found that fenthion and phenthoate were the two compounds which fulfilled all the criteria and were used in this project.

TABLE 26. REDUCTION IN BREEDING SOURCE FOLLOWING CLEANING, DESILTING, AND DEWEEDING OF DRAINS CARRIED OUT WEEKLY DURING THE STUDY PERIOD.

Year	"U" Canals/Drains		"L" Drains		"K" Drains	
	Surface area reduced (M^2)	Money spent(Rs)	Surface area reduced (M^2)	Money spent (Rs)	Surface area reduced (M^2)	Money spent(Rs)
1981	126477.79	16,784	44,101.43	3,696	57,091.45	5,496
1982	620,504.9	37,980	324,622.7	8,748	129,114.85	7,218
1983	1,251,984.2	59,880	1,253,554.7	17,350	659,039.65	17,760
1984	571,746.1	52,338	223,531.0	38,467	130,573.20	39,006
1985	793,206.5	81,108	411,068.0	72,456	173,494.2	62,880
TOTAL	3,363,919.4	248,090	2,256,877.8	140,717	1,149,313.3	132,360

Total money spent in Rupees—5 21, 167 for different types of drains.

Channelization of a breeding habitat to reduce surface area. Above: before channelization. Below: After channelization.

Spraying of insecticide in a cesspit (above) and 'U' drain (below).

TABLE 27. DETAILS AND BENEFITS OF CHANNELIZATION WORK CARRIED OUT IN DIFFERENT YEARS DURING THE STUDY PERIOD TO PREVENT VECTOR BREEDING.

Year	Month	Locality	Surface area m^2	Money spent	Insecticide saved per annum(lit)	Cost of Insecticide saved per year	Cost of Insecticide saved during the project period	Net saving
1981	3	Kompakkam	142	400	2.735	394	1,576	1,176
	4	Murungapakkam	90	480	1.733	250	1,000	520
	10	Ellango Nagar	144	800	2.773	399	1,596	796
	7	Vengata Nagar (Behind paddy field (a)	167	480	3.216	463	1,852	1,372
	8	Asoka Nursing Home Back side (b)	279	192	5.373	774	3,096	2904
	11	Rainbow Nagar	324	400	6.240	899	3,596	3,196
		Total	1,146	2,752	22.070	3,179	12,716	9,964
1982	9	Sathya nagar	1,866	480	35.938	5,748	17,244	16,764
	7	Karuvadikuppam	70	201	1.348	250	750	549
	6	Keerapalayam	278	495	5.354	856	2568	2073
	4	Vanarapet	1,039	230	20.010	3,202	9606	9,376
		Total	3,253	1,406	62.650	10,056	30,168	28,762
1983	6	Saram	4,448	3241	85.665	13707	27,414	24173
	2	Raja Nagar(Orleanpet)	115	364	2.215	354	708	344
	7	Karuvadikuppam	137	486	2.639	423	846	360
		Total	4,700	4,091	90.519	14484	28,968	24877
1984	6	Thendral Nagar(Saram)	9,705	83	186.911	42,616	42,616	42,533
	4	Kennedy Nagar	175	20	3.370	768	768	748
	11	Vambakeerapalayam	520	578	10.015	2,283	2,283	1,705
		Total	10,400	681	200.296	45,667	45,667	44,986
1985		-NIL-	-NIL-	-NIL-	-NIL-	-NIL-	-NIL-	-NIL-
		Grand Total	19,499	8,930	375.535	73,386	117,519	108,589

TABLE 28 . COST BENEFIT ANALYSIS OF BREEDING SOURCE REDUCTION BY PUMPING OUT WATER

Year	Surface area reduced ($_m$2)	Volume of water in lit. pumped out	Money spent	Insecticide saved per annum (lit.)	Cost of insecticide saved/year (Rupees)	Cost of insecticide saved during project period (Rupees)	Net saving
1981	6,370.8	68,57,670	335.00	122.7	17,668.00	70,672.00	70,337.00
1982	12,764.3	2,10,75,000	706.00	245.8	39,329.00	1,17,987.00	1,17,281.00
1983	31,725.0	1,64,52,500	1,345.00	611.0	97,760.00	1,95,520.00	1,94,175.00
1984*	Nil	Nil	Nil	Nil	Nil	Nil	Nil
1985*	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TOTAL	50,860.1	4,43,85,170	2,386.00	979.53	1,54,757.00	3,84,179.00	3,81,793.00

* 1984 onwards pumping of water from stagnant vacant plot was handed over to Municipalities.

TABLE 29. DETAILS OF SEA WATER PUMPING WORK DONE TO FLUSH THE BOX DRAIN

Place of Operation	Volume of Water pumped out in litres	Surface area reduced in sq.mts.	Cost in Rupees.
Mill Road Drain	12,000	650	19
Keerapalayam Drain	15,000	408.5	22
Keerapalayam Drain	12,000	408.5	11

These insecticides were used in a grid pattern to prevent resistance development and susceptibility was monitored continuously. Besides fenthion and phenthoate, other insecticides like Fendona, (a synthetic pyrethroid), Monomolecular surface film (Monoxci (R), DDVP (OP), Fenfluthrin (Synthetic pyrethroid), etc. were also used on experimental basis. Since the effect of fenthion and phenthoate is appreciable only against the larval instars a mixture of ML oil with either of these compound was used to treat breeding habitats with pupal stage.

Dose determination:

To determine the most effective and economic dose, average walking speed of spraymen, the discharge rate of the sprayer, and the time taken to get 100% kill were calculated. The distance covered by the spraymen varied and the average speed was 35 mt/min. $\pm$ 3 mt/min. It was found that the pressure must be maintained between 25 lbs/sq. in and 40 lbs/sq. in and within the working pressure the average discharge rate of spray fluid in the hand compression sprayer was found to be 825 ml/min. $\pm$ 60.64 ml/min. Subsequently it was noticed that the sprayman continued to spray even if pressure dropped below the desired level. As a result some of the pits were treated with high dose and some were treated with less insecticide. Therefore, knapsack sprayers were used where constant pressures could be maintained without interruption.

The discharge rate was found to be 680 ml/min. Time taken to get 100% kill in cesspits and drains was calculated and summarized in Table 30.

Frequency and dosage of application:

Insecticide application followed scheduled strategies which required regular application of insecticide to a specific life stage at pre determined times and places throughout the breeding season (Birley and Davies, 1984). Though minimal monitoring is required in this strategy a full scale evaluation team monitored the breeding status. The feed back strategy (which implies treating as and when breeding occurred) could have been followed to reduce operational cost, but this was found impracticable in the present programme due to the following reasons.

The level of education of staff employed for spraying was not adequate to utilize the results of evaluation and take appropriate action. Many breeding habitats were missed. Therefore all the breeding habitats were routinely treated at weekly intervals. Efficacy of fenthion and phenthoate in the field was compared and it was found that fenthion was more persistant than phenthoate. However, phenthoate could kill larva much faster than fenthion. Since, phenthoate gave immediate kill it was used in slow flowing and stagnant drains whereas all other habitats were treated with fenthion.

Since a sprayman will be walking at a speed of 35 mt/min. and the average discharge rate of nozzles at 825 ml/min. and with the target concentration at 0.5 ppm, it was found sufficient to charge the sprayers with 1000 ppm solution of fenthion and phenthoate by adding 1.12 ml/lit (82.5% EC) and 2.0 ml/lit (50% EC) of the respective insecticides.

In some drains where insecticide could not be sprayed a drip applicator (Fig. 49) was used. A drip applicator was deviced which consisted of a polythene bag (15 Cm $\times$ 8 Cm) with a jute wick of about 35 cm length. The polythene bag was filled with required amount of insecticide and one end of the wick was immersed in the insecticide and the other end was drawn out through a small hole at the upper portion of the bag. The release rate was controlled by adjusting the length of the wick. The rate of flow of pesticide concentration in ml./min. was calculated by using standard formula (WHO, 1974).

These applicators were deployed 50 cm above the water surface at regular intervals over the entire length of the drain. Refilling of the chemical was attended to every 10th day and the same applicator was used several times. It was found that emergence could be prevented by this method upto 8 days as against 4 days by spraying. The cost benefit analysis showed that use of this method can lead to saving of Rs. 2,534 (US $ 253) per km. length of drain per year in the form of man power and insecticide in comparison to spraying method (Table 31). Moreover, this is the most efficient method applicable in closed box drains.

Breeding habitats in Zones 3, 4, 5 and 6 were

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TABLE 30. FIELD TRIAL WITH BAYTEX (FENTHION) AND PHENDAL (PHENTHOATE) IN CESSPITS AND L-DRAINS.

Sl. No.	Concentration used in ppm	Cesspits				L Drains	
		Time taken (minutes) for 100% mortality of larvae in Baytex spray	Day of appearance of 4th instar larvae in Baytex sprayed pits	Time taken (minutes) for 100% mortality of larvae in Phendal spray	Day of appearance of 4th instar larvae in Phendal sprayed pits	Time taken (minutes) for 100% mortality of larvae in Baytex spray	Time taken (minutes) for 100% mortality of larvae in Phendal spray
1.	0.1	90±5.54	-	60±4.90	-	105±6.59	85±3.2
2.	0.2	65±3.37	-	50±10.00	-	90±3.36	78±1.58
3.	0.3	58±3.97	-	45±2.51	-	74±2.9	65±2.42
4.	0.4	42±4.83	6.0	35±2.42	6.0	60±3.27	55±2.69
5.	0.5	35±3.86	6.0	30±2.10	6.0	50±3.46	45±3.07
6.	0.6	32±3.91	-	20±1.84	-	40±2.57	30±3.09
7.	0.7	25±3.31	7.0	15±1.29	7.0	28±1.51	25±2.37
8.	0.8	18±2.15	-	12±1.53	-	25±2.03	20±1.97
9.	0.9	15±3.30	-	10±0.97	-	20± 2.16	15±2.24
10.	1.0	15±3.50	8.0	10±1.71	8.5	20±1.55	15±1.31

Values are means ± SDs of 10 observations

Drip applicator in use.

TABLE 31. COST BENEFIT ANALYSIS OF INSECTICIDE SPRAY METHOD AND DRIP APPLICATION METHOD

Name of the U Drain	Conventional Spray Method						Drip Applicator Method					Money spent by spray method per year	Money spent by drip applicator method Per Year	Net Saving per year in Rupees
	Length in kms	Insecticide consumed in Liter Per, week	Man days spent per week	Money spent in Rs.for			Insecticide consumed in Liter per week	Man days spent per week	Money spent in Rs.for					
				Consumption of insecticide/ week	Man power per week	Total cost per week			Consumption of insecticide per week	Man power per week	Total cost per Week			
Kamaraj Salai I	0.5	0.4	1.0	69.6	9.00	78.60	0.2	0.25	34.80	2.25	37.05	4,087.20	1,926.60	2,160.60
Kamaraj Salai II	0.6	0.4	1.0	69.6	9.00	78.60	0.2	0.25	34.80	2.25	37.05	4,087.20	1,926.60	2,160.60
Govinda-salai	0.6	0.3	1.0	52.2	9.00	61.20	0.1	0.25	17.40	2.25	19.65	3,182.40	1,021.80	2,160.60
Anna-Salai	0.1	0.1	0.25	17.4	2.25	19.65	0.05	0.05	8.70	0.45	9.15	1,021.80	475.80	546.00
Karuva-dikuppam	1.3	0.2	0.5	34.8	4.50	39.30	0.1	0.5	17.40	4.50	21.90	2043.60	1,138.80	904.80
TOTAL	3.1	1.4	3.75	243.6	33.75	277.35	0.65	1.3	113.10	11.70	124.80	14,422.20	6,489.60	7,932.60

Rupees 2,534/ saved per KM length of drain per year in the form of man power and insecticide by Drip Applicator Method.

treated routinely. The quantity of various insecticides used, during project period is summarized (Table 32). The quantity of insecticides used for vector control could not be reduced because of formation of additional habitat in developed colonies.

Monitoring cholinesterase activity in spraymen:

The spraymen, supervising staff, distributors and mechanics were exposed to the risk of insecticidal contact. Therefore, cholinesterase (CHE) activity was monitored at regular intervals by using Lovibond cholinesterase test kit. Results of the tests are summarized in Table 33.

Initially 87 workers were tested for CHE activity. Among them 72 were found to fall under group A (75–100%) activity, 12 under "B" (50–75%) and 3 under "C" (25–50%) group activity. Since the normal value of cholinesterase activity in tropical countries lies in the range of 75% to 87% no action was initiated in the case of those falling in "A" group.

The persons under "B" and "C" groups were changed from spraying operation to sanitation and fish release works. After three months CHE activity of fourteen persons classified earlier as "B" & "C" were checked again, out of these 9 showed cholinesterase activity of "A" level, 3 of "B" and 2 of "C" levels. The two spraymen showing "C" level of cholinesterase activity were referred to Health Centre for further investigation.

Since the workers were engaged in the project for spray operation on hired basis, very few of them continued to work till the completion of the project. In each test, on the average 11–12 persons showed CHE activity of "B" and "C" level and were subsequently withdrawn from spray operations.

Monitoring Resistance Development:

Regular monitoring of the larval susceptibility status of the vector was done to detect the resistance development. Fourth instar larvae from FCDP areas (Zones 3, 4, 5 and 6) and NFCP areas (Zones 1, 2 and 7) were collected at six monthly intervals for monitoring susceptibility of vector species against fenthion and phenthoate by following standard method. (WHO, 1975).

Results of routine monitoring are summarized in Tables 34a 34b. Tolerance was exhibited by *Cx. quinquefasciatus* from both FCDP and NFCP areas, but more pronounced in FCDP areas.

It may be stated that in FCDP areas relatively high quantity of insecticides was used frequently to control larval population. Consequently the selection pressure on the vector species under the FCDP operation was naturally higher and hence a relatively higher increase in the LC50 values in FCDP areas.

A detailed study was also undertaken to determine tolerance level in larvae from different areas and their cross tolerance to other insecticides. Early fourth instar larvae were collected from ten different localities, viz, Boulward, M.G.Road (Zone I), VOC Nagar, Muthialpet (Zone II), Kottakuppam, (Zone III), Kosapalayam, Govindasalai (Zone IV), Mudaliarpet (Zone V), Kasthurbai Nagar and Kadhirkammam (Zone VI) and tested for susceptibility to DDT, Malathion, Fenthion, Fenitrothion, Phenthoate, Temephos, Zolone, Chlorpyriphos, Permethrin, Pyrethrum and Fenvalerate.

The susceptibility status of *Cx. quinquefasciatus* collected from different localities of Pondicherry is presented in Table 35a & 35b.

In the beginning when the control programme was initiated *Cx. quinquefasciatus* was tolerant to DDT but was susceptible to most of the organophosphorous and pyrethroid compounds. However, the use of two organophosphorous insecticides namely fenthion and phenthoate for three to four years and occasional use of Zolone and Dursban have selected tolerant strains in the vector causing 10 to 20 fold increase in LC50 values. Increase in tolerance was not only restricted to organophosphorous compounds but also to many other unevaluated compounds. Also the increase in tolerance was not restricted to the area where selection pressure is continued but was also seen in the area where no such selection is in operation. This is probably due to movement of susceptible and resistant mosquitoes between NFCP and FCDP areas. However, high heterogenity in the tolerance level of the population clearly indicates that the population migration within the area is limited and exposed to different

TABLE 32. SUMMARY DATA OF VARIOUS INSECTICIDES CONSUMED IN DIFFERENT YEARS

S.No:	Name of the Insecticides	Quantity consumed in Litres					
		1981	1982	1983	1984	1985	Total
1.	Fenthion (82.5% EC)	590.630	783.150	590.470	813.525	658.180	3435.955
2.	Phenthoate (50% EC)	201.297	274.290	569.101	1159.316	679.450	2883.454
3.	Malariol	15.740	376.731	459.875	3049.606	1311.820	5213.772
4.	Monoxci	Nil	Nil	71.700	Nil	Nil	71.700
5.	Fendona	Nil	Nil	Nil	Nil	218.605	218.605
6.	Fenitrothion	Nil	Nil	Nil	Nil	52.350	52.350
7.	Hexachlor	-	-	-	-	10.850	10.850
8.	Dichlorvos (DDVP)	-	-	-	-	39.960	39.960
9.	Folithion	-	-	-	-	1.600	1.600
10.	Sumithion	-	-	-	-	1.000	1.000
11.	Pyrethrum	-	-	-	-	50.150	50.150
12.	Malathion	-	-	-	-	9.300	9.300

TABLE 33. CHOLINESTERASE(CHE) ACTIVITY OF PERSONS INVOLVED IN INSECTICIDES SPRAY OPERATIONS.

Period of Examination	No. of persons Examined	No.of persons in Grades			
		A 100-75%	B 75-50%	C 50-25%	D 25-10%
Jun - 1982	87	72	12	3	Nil
Oct - 1982	14	9	3	2	Nil
Feb - 1983	71	54	11	6	Nil
Jul - 1983	71	60	5	6	Nil
Apr - 1984	69	49	14	6	Nil

TABLE 34 a. SUSCEPTIBILITY STATUS OF C. quinquefasciatus FIELD STRAIN AGAINST FENTHION (82.5 % EC)

Period	FCDP AREA					NFCU AREA				
	Heterogenity $x^2(n-2)=$	Regression equation $y = a+bx$	LC_{50} (ppm)	Fiducial limits with 95% confidence		Heterogenity $x^2(n-2)=$	Regression equation $y = a+bx$	LC_{50} (ppm)	Fiducial Limits with 95% confidence	
				Upper	Lower				Upper	Lower
PRE CONTROL			0.003					0.003		
JAN 1981	x^2 (4) = 5.97	y = 1.76 + 2.51 x	0.0195	0.0228	0.0166	x^2 (6) = 22.81	y = 2.87 + 1.85 x	0.0142	0.0182	0.0112
JUN 1981	x^2 (4) = 31.25	y= -0.415+ 3.79 x	0.0269	0.0346	0.0209	x^2 (3) = 5.57	y = 3.68 + 1.57 x	0.00696	0.009	0.0054
JAN 1982	x^2 (3) = 51.0	y = 0.033+ 5.42 x	0.0083	0.0107	0.0063	x^2 (4) = 11.3	y = 3.23 + 2.64 x	0.0047	0.0057	0.0039
JUN 1982	x^2 (4) = 32.95	y= -0.34 + 3.76 x	0.0263	0.0516	0.0134	x^2 (4) = 4.53	y = 0.72 + 3.58 x	0.0157	0.0174	0.0141
JAN 1983	x^2 (5) = 11.32	y = 1.02 + 2.49 x	0.0396	0.0477	0.0328		- NOT DONE -			
JUN 1983	x^2 (4) = 26.28	y = 0.76 + 3.15 x	0.0225	0.0325	0.0152	x^2 (5) = 5.15	y = -2.05 + 9.79 x	0.0052	0.0054	0.0051
JAN 1984	x^2 (5) = 25.14	y = 2.0616+4.322x	0.0478	0.0552	0.0415	x^2 (4) = 1.758	y= -1.351 + 4.622x	0.0237	0.0252	0.0223
JUN 1984	x^2 (3) = 20.77	y = 2.528+ 4.757x	0.0331	0.0390	0.0281	x^2 (3) = 0.784	y= -1.0405+ 4.65 x	0.0199	0.0213	0.0186
JAN 1985	x^2 (4) = 3.7	y =10.77 + 4.26 x	0.0442	0.0499	0.0392	x^2 (4) = 1.85	y = 11.104 + 3.47 x	0.0174	0.0208	0.0145
JUN 1985	x^2 (5) = 4.56	y =11.95 + 4.11 x	0.0203	0.0177	0.0233		- NOT DONE -			

TABLE 34 b. SUSCEPTIBILITY STATUS OF C. quinquefasciatus FIELD STRAIN AGAINST PHENTHOATE (50 % EC)

Period	FCDP AREA: Heterogenity $x^2(n-2)=$	Regression equation $y= a+bx$	LC_{50} (ppm)	Fiducial limits with 95% confidence: Upper	Lower	NFCU AREA: Heterogenity $x^2(n-2)=$	Regression equation $y= a+bx$	LC_{50} (ppm)	Fiducial Limits with 95% confidence: Upper	Lower
PRE CONTROL			0.006					0.006		
JAN.1981	x^2 (5) = 3.09	y = -1.18 + 5.82 x	0.0115	0.0121	0.0109	— NOT DONE —				
JUN.1981	x^2 (4) = 10.27	y = -0.18 + 4.71 x	0.0126	0.0139	0.0114	x^2 (3) = 5.88	y = 1.083 + 4.39x	0.0078	0.0084	0.0072
JAN.1982	x^2 (5) = 44.72	y = 2.48 + 3.99 x	0.0043	0.0052	0.0035	x^2 (4) = 3.24	y = 3.34 + 3.65x	0.0029	0.0032	0.0026
JUN.1982	x^2 (4) =249.5	y = 1.96 + 3.69 x	0.0067	0.0119	0.0037	x^2 (3) =200.17	y = 3.85 + 2.79x	0.0026	0.0087	0.0013
JAN.1983	x^2 (5) = 13.83	y = 0.98 + 4.25 x	0.0088	0.010	0.0077	— NOT DONE —				
JUN.1983	x^2 (4) = 41.74	y = 1.83 + 4.0 x	0.0062	0.0088	0.0044	x^2 (3) = 5.15	y = -2.05 + 9.79x	0.00524	0.0054	0.0051
JAN.1984	x^2 (3) = 14.31	y = -0.3085+4.66 x	0.0138	0.0163	0.0117	x^2 (3) = 35.25	y = 1.6307+ 3.7678x	0.0078	0.0099	0.0061
JUN.1984	x^2 (4) = 13.23	y = -0.8456+5.717 x	0.0106	0.0116	0.0097	x^2 (4) = 13.85	y = 1.898 + 3.95 x	0.0061	0.007	0.0053
JAN.1985	x^2 (3) = 1.09	y = 12.9 + 4.64 x	0.0198	0.0224	0.0175	x^2 (3) = 2.22	y = 21.3 + 8.32 x	0.011	0.0120	0.0101
JUN.1985	x^2 (5) = 3.55	y = 15.47 + 5.27 x	0.0103	0.009	0.0115	— NOT DONE —				

TABLE 35a. LC_{50} (ppm) VALUES FOR *Cx. quinquefasciatus* FOURTH INSTAR LARVAE WITH DIFFERENT INSECTICIDES IN NFCU AREAS. (Level of signifigances are in paranthesis)

Insecticides	Pre control General	Locations (Zone-LEZ)			
		Bouleward (1-1)	M.G.Road (1 - 2)	Muthialpet (2-5)	V.O.C.Nagar (2-6)
DDT	0.04 (> .01)	0.2671 (>0.05)	0.3491 (>0.05)	0.0437 (<0.05)	0.0584 (>0.05
MALATHION	0.018	0.0661 (> .05)	0.1507 (< .05)	0.1453 (> .05)	0.0991 (> .05
FENTHION	0.0029	0.0187 (< .05)	0.0199 (> .05)	0.0216 (> .05)	0.0280 (> .05)
FENITROTHION	-ND-	0.0249 (> .05)	0.0218 (< .05)	0.0119 (> .05)	0.0273 (> .05)
PHENDAL	0.0056	0.0069 (< .05)	0.0061 (< .05)	0.0066 (> .05)	0.0126 (> .05)
TEMEPHOS	0.0004	0.001 (< .05)	0.0013 (> .05)	0.0045 (> .05)	0.0011 (< .05)
ZOLONE	0.1920	0.1762 (> .05)	0.2097 (> .05)	0.1463 (< .05)	0.3135 (< .05)
CHLORPYRIPHOS	-ND-	0.0070 (< .05)	0.0067 (> .05)	0.0117 (< .05)	0.0090 (> .05)
PERMETHRIN	0.0017	0.0051 (> .05)	0.0060 (> .05)	0.0068 (< .05)	0.0068 (< .05)
PYRETHRUM	-ND-	0.0628 (> .05)	0.1146 (< .05)	0.0313 (< .05)	0.0812 (> .05)
FENVELERATE	-ND-	0.0051 (< .05)	0.0076 (> .05)	0.0030 (< .05)	0.0058 (> .05)

ND - Not done

TABLE 35b. LC_{50} (ppm) VALUES FOR *Cx. quinquefasciatus* FOURTH INSTAR LARVAE WITH DIFFERENT INSECTICIDES IN VCRC AREAS. (Level of signifigances are in paranthesis)

Insecticides	Locations (Zone-LEZ)					
	Kottakuppam (3-7)	Kosapalayam (4-25)	Govindasalai (4-30)	Mudaliar-pet (5-33)	Kasthuri-bai Nagar (6-45)	Kathirkai (6-46
DDT	0.1820 (<0.05)	0.6166 (<0.05)	0.1820 (< 0.05)	0.3074 (<0.05)	0.3311 (<0.05)	0.375 (<0.05
MALATHION	0.0550 (<.05)	0.3508 (> .05)	0.195 (> .05)	0.3159 (< .05)	0.1905 (< .05)	0.157 (> .05
FENTHION	0.0407 (< .05)	0.0501 (> .05)	0.0214 (< .05)	0.0333 (< .05)	0.0331 (< .05)	0.030 (> .05
FENITROTHION	0.0135 (> .05)	0.0164 (< .05)	0.0493 (< .05)	0.0277 (> .05)	0.0316 (< .05)	0.018 (> .05
PHENDAL	0.0056 (< .05)	0.0079 (> .05)	0.0129 (< .05)	0.0125 (> .05)	0.0106 (< .05)	0.009 (> .05
TEMEPHOS	0.0039 (< .05)	0.0075 (> .05)	0.0044 (< .05)	0.0074 (< .05)	0.0076 (> .05)	0.001 (< .05
ZOLONE	0.1122 (<.05)	0.3236 (< .05)	0.4672 (< .05)	0.3904 (> .05)	0.3080 (> .05)	0.390 (> .05
CHLORPYRIPHOS	0.0017 (< .05	0.0062 (> .05)	0.0062 (> .05)	0.0035 (> .05)	0.0067 (< .05)	0.007 (> .05
PERMETHRIN	0.0089 (<.05)	0.0047 (< .05)	0.0085 (> .05)	0.0088 (<.05)	0.0117 (> .05)	0.009 (> .05
PYRETHRUM	0.0337 (<.05)	0.0525 (<.05)	0.1072 (> .05)	0.0759 (> .05)	0.0447 (< .05)	0.075 (< .05
FENVELERATE	0.0032 (<.05)	0.0083 (<.05)	0.0109 (<.05)	-ND-	0.0026 (> .05)	0.014 (> .05

ND - Not done

degrees of selection. Since the selection in FCDP area is high, tolerance recorded in the FCDP area is well marked. It is well known that continuous selection with insecticides increases vigour of the mosquitoes thereby enabling them to withstand even a higher dosage of insecticides. In Rangoon, where fenthion was used for two years for *Cx. quinquefasciatus* control no such increase in tolerance was recorded (Tun and Self, 1968).

Inspite of the increase in tolerance, operationally the same rate of application of insecticide was still found to be effective in controlling *Cx. quinquefasciatus* immatures in different breeding habitats in Pondicherry urban area.

However, to increase the effective life of the insecticide, selection pressure was reduced by changing over to other alternate and unrelated compounds and relying on environmental methods. The study conclusively proves that development of tolerance in immatures to fenthion and phenthoate never reached a level where the insecticides became operationally inefficient.

5.3.3. Biological control:

The larvivorous fishes play a significant role in reducing the vector breeding in the habitats where survival of fish is not jeopardised. The utility of surface feeding fishes for biological control of mosquitoes has been studied extensively in many parts of the world (Hora and Muckerjee 1937, Gerberich and Laird 1968, Jhingran 1975, Sitaraman *et al.*, 1975, and Menon and Rajagopalan, 1978). The role of *G. affinis* in controlling mosquito breeding in wells had been demonstrated in urban areas of Pondicherry (Menon and Rajagopalan, 1978). Even though the wells are not the major contributors for *Cx. quinquefasciatus*, some unused wells support breeding. It was estimated in earlier studies by Menon and Rajagopalan, 1978 that while 11.9% of wells support *Cx. quinquefasciatus* breeding, 32.8% supported breeding of other species.

Fish was introduced in all the wells to control culicine as well as anopheline breeding.

A zonewise survey was conducted during 1980 to collect base line information on the number of used and unused wells supporting mosquito breeding. The presence of predator fish in these wells was also recorded. Irrespective of the breeding status fish release was undertaken where fishes were naturally absent.

Resurvey of all the wells was made after six months to measure the impact of fish release upon mosquito breeding. Subsequently surveys were carried out at quarterly intervals and fishes were released wherever necessary. The number of wells surveyed and fishes introduced during the project period was given in the Table 36.

Though a gradual decline was observed in the proportion of wells supporting mosquito breeding, a few wells continued to breed profusely. It was due to either the frequent disturbance of water or the nature of water that induced mortality in fish. It was observed that *Gambusia* is comparatively less agile and can be picked up by the bucket very easily. In some wells the floating garbage prevented effective predation. Thus frequent introduction of fish was necessary.

The total surface area of wells covered in the initial stage of the project was 598 sq. mt. and at the end it was 2278 sq. mt. The total surface area supporting *Cx. quinquefasciatus* pupae was 27 sq. mt. in the beginning which decreased to zero at the end of the project.

Though the control measures were primarily aimed at *Cx. quinquefasciatus*, a remarkable reduction in the breeding of anophelines was noticed. The percentage of wells found to breed anophelines is also given in the Table 36.

Cesspools / Vacant plots:

Fish release was also done in the habitats like cesspools and vacant plots where chemical and environmental methods could not be used. Frequent introduction of fish was found to be very effective in keeping these habitats free from mosquito breeding. The density of *Cx. tritaeniorhynchus*, *An. subpictus*, and *Cx. quinquefasciatus* were brought down to negligible level by *Gambusia* and *Tilapia*.

TABLE 36. DETAILS ON THE WELL SURVEY DURING 1980-1985 IN PONDICHERRY

Years	Number of survey in a year	Mean No. of wells surveyed				Mean No.of wells +ve for immatures of Cx. quinquefasciatus.	Mean No. of wells +ve for Anophelines	Action taken			Mean No. of wells +ve for Pupae of Cx.quinquefasciatus.	Mean surface area +ve for Cx.quinquefasciatus (m^2)	Mean surface area (m^2) of wells
		Used	Dis Used	Dry	Total			Mean No.of wells fish relea-sed	Mean No.of wells spra-yed	Total wells closed in each year			
1980	1	448 (76.7)	114 (19.5)	22 (3.8)	584	74 (12.6)	101 (17.2)	568 (97.2)	ND	ND	29 (4.9)	27.0	598.0
1981	3	1,352 (61.5)	572 (26.0)	274 (12.4)	2,198	125 (5.6)	94 (4.2)	1894 (86.2)	2 (0.1)	56	61 (2.8)	51.0	1,750.0
1982	4	1,843 (72.5)	388 (15.3)	307 (12.1)	2,529	98 (3.8)	76 (3.0)	246 (9.7)	6 (0.2)	67	47 (1.9)	38.0	2,018.0
1983	8	1,834 (71.1)	319 (12.4)	426 (16.5)	2,579	81 (3.1)	52 (2.0)	1629 (63.0)	75 (2.9)	296	31 (1.2)	28.0	1,968.0
1984	12	2,490 (84.2)	360 (12.2)	109 (3.7)	2,959	32 (1.1)	1 (0.03)	415 (14.0)	148 (5.0)	199	11 (0.4)	9.0	2,057.0
1985	12	1,967 (66.7)	489 (16.5)	499 (16.9)	2,955	7 (0.2)	0	70 (2.4)	120 (4.1)	66	0	0	2,278.0

ND- Not done

Figures in the paranthesis are precentages.

6. EVALUATION

The effectiveness of the vector control measures were evaluated by monitoring the fluctuation in vector densities in different areas and changes in the microfilaria rate of the population particularly in 0–5 age group at the end of five years.

Entomological evaluation was done through indoor resting and night biting collections from fixed catching stations and some randomly selected stations. The results of the evaluations were constantly fed back to the control teams to take corrective measures. Similarly to know the impact of control measures on microfilaria, blood surveys were carried out at the beginning and at the end of the project. The results of the entomological and parasitological evaluations are presented and discussed.

6.1. Entomological Evaluation:

Impact of vector control on entomological parameters was assessed by evaluating resting and biting density from the fixed catching stations. The resting and biting mosquitoes were dissected in the laboratory to determine the parous, infection and infectivity rates.

6.1.1. Species composition:

From indoor resting and night biting collections, 25 species of mosquitoes belonging to 5 genera were collected. In indoor resting and night biting collection *Cx. quinquefasciatus* was the dominant species throughout the year. The next dominant species among culicines was *Cx. vishnui* gr. which includes the J.E. vector species. Among anophelines *An. subpictus* was found to be the dominant species.

In indoor resting collection, a total of 178,620 female mosquitoes belonging to 5 genera and 20 species were collected. *Cx. quinquefasciatus* comprised 53.4% of the total catch. The second most abundant species was *An. subpictus* which comprised 29.5% of the total catch. The other mosquitoes collected in significant numbers were *Cx. vishnui* gr. (9.6%), *Cx. sitiens* (3.7%), *Ae. aegypti* (2.7%), and very few number of other species. The number and proportion of different species of mosquitoes are summarized in Table. 37.

In human biting collection also *Cx. quinquefasciatus* was the dominant species (Table 38). Among the total collected, *Cx. quinquefasciatus* formed 54.1%. The second abundant species was *Cx. vishnui* gr. (24.3%). Other species collected in significant numbers were *Cx. sitiens* (2.9%), *Cx. hitaeniorhynchus* (2.7%), *An. subpictus* (5.1%), *Ae. aegypti* (2.2%), *M. annulifera* (3.6%) and *Ar. subalbatus* (3.5%). Other species were collected in fewer numbers (Table 38). The representative samples from these species were dissected to determine filarial infection. Only *Cx. quinquefasciatus* was found to be the vector and no other species had infective stage larvae. The year wise species composition remained unchanged.

6.1.2. Indoor resting density (females/man hour) of *Cx. quinquefasciatus:*

The indoor resting density of the vector from month to month, year to year and also from Zone to Zone (Tables 39 & 40). Generally the indoor resting density was relatively low in summer months gradually decreasing from January to June which is the hottest month. The same trend was observed in all zones throughout the study period.

The indoor resting density of *Cx. quinquefasciatus* declined substantially from 55/man hour in 1980 to 25 in 1981 for VCRC operated areas. This declining trend continued upto 1984 when it reached the lowest density of 3.6/man hour. However, in 1985 density increased slightly to 6.9/man hour (Table 40). In NFCP zone the fall in density was not marked and density was higher than that of any VCRC zones throughout the study period (Fig 50).

The first year of control operation resulted in reduction in density in all VCRC zones, maximum being in Zone III (17.4/man hour), whereas in NFCP zone it was 55.7 females per man hour. While the density declined in all VCRC zones till 1984, Zone 4 had a comparatively higher density throughout the study period where density ranged

TABLE 37. SPECIES COMPOSITION OF INDOOR RESTING MOSQUITOES

Species	1981		1982		1983		1984		1985		Total	
	No. Collected	%	No. Collected	%	No. Collected	%	No. Collected	%	No. Collected	%	No. Collected	%
Cx.quinquefasciatus	25,380	55.0	24,487	53.6	17,687	57.3	12,614	49.5	15,213	50.0	95,381	53.4
Cx.vishnui	3,077	6.7	4,820	10.6	3,048	9.9	2,933	11.5	3,309	10.9	17,187	9.6
Cx.sitiens	1,931	4.2	3,389	7.4	774	2.5	274	1.1	278	0.9	6,646	3.7
Cx.bitaeniorhynchus	30	0.1	27	0.1	18	0.1	26	0.1	23	0.1	124	0.1
Cx.(L)fuscanus	10	0.02	2	0.004	8	0.03	4	0.02	6	0.02	30	0.02
Cx.whitmorei	3	0.01	3	0.01	4	0.01	0	0	0	0	10	0.01
Cx.gelidus	7	0.02	3	0.01	9	0.03	5	0.02	11	0.04	35	0.02
An.subpictus	13,954	30.2	11,083	24.3	8,262	26.8	8,526	33.5	10,833	35.6	52,658	29.5
An.vagus	448	1.0	253	0.6	200	0.7	145	0.6	31	0.1	1,077	0.6
An.stephensi	0	0	0	0	2	0.01	0	0	0	0	2	0.001
An.hyrcanus	0	0	0	0	0	0	0	0	1	0.003	1	0.001
An.barbirostris	1	0.002	1	0.002	0	0	0	0	0	0	2	0.001
An.pallidus	0	0	2	0.004	0	0	0	0	0	0	2	0.001
Ae.aegypti	1,238	2.7	1,451	3.2	746	2.4	772	3.0	605	2.0	4,812	2.7
Ae.albopictus	0	0	0	0	0	0	1	0.004	0	0	1	0.001
Ae.vittatus	1	0.002	0	0	0	0	0	0	0	0	1	0.001
M[illegible].annulifera	10	0.02	4	0.01	7	0.002	37	0.2	5	0.02	63	0.04
M[illegible].uniformis	2	0.004	1	0.002	0	0	1	0.004	0	0	4	0.002
M[illegible].crassipes	0	0	1	0.002	0	0	0	0	0	0	1	0.001
Ar.subalbatus	93	0.2	149	0.3	105	0.3	121	0.5	113	0.4	581	0.3

TABLE 38. SPECIES COMPOSITION OF NIGHT BITING MOSQUITOES

Species	1981		1982		1983		1984		1985		Total	
	No.collected	%	No.collected	%	No.collected	%	No.collected	%	No. collected	%	No.collected	%
Cx. quinquefasciatus	3505	75.2	1962	53.5	1956	51.1	2213	39.4	3774	53.9	13410	54.1
Cx. vishnui	622	13.3	624	17.0	959	25.0	1706	30.4	2119	30.3	6030	24.3
Cx. sitiens	72	1.5	394	10.8	83	2.2	72	1.3	105	1.5	726	2.9
Cx. bitaeniorhynchus	75	1.6	132	3.6	182	4.8	229	4.1	54	0.8	672	2.7
Cx. (L) fuscanus	16	0.3	2	0.1	9	0.2	1	0.02	2	0.03	30	0.1
Cx. whitmorei	1	0.02	1	0.03	0	0	0	0	0	0	2	0.01
Cx. gelidus	2	0.04	7	0.2	6	0.2	8	0.1	4	0.1	27	0.1
Cx. fuscocephalus	0	0	0	0	0	0	1	0.02	0	0	1	0.004
An. subpictus	104	2.2	73	2.0	197	5.1	300	5.3	596	8.5	1270	5.1
An. vagus	2	0.04	4	0.1	5	0.1	1	0.02	1	0.01	13	0.1
An. hyrcanus	0	0	0	0	10	0.3	6	0.1	5	0.1	21	0.1
An. barbirostris	0	0	0	0	0	0	2	0.04	3	0.04	5	0.02
An. pallidus	1	0.02	0	0	1	0.03	4	0.1	1	0.01	7	0.03
An. nigerrimus	5	0.1	3	0.1	2	0.1	0	0	0	0	10	0.04
An. annularis	0	0	0	0	0	0	1	0.02	0	0	1	0.004
Ae. aegypti	139	3.0	179	4.9	102	2.7	40	0.7	72	1.0	532	2.2
Ae. albopictus	4	0.1	1	0.03	0	0	4	0.1	1	0.01	10	0.04
Ae. vittatus	0	0	0	0	3	0.1	0	0	1	0.01	4	0.02
Ae. jamesi	0	0	0	0	0	0	2	0.04	0	0	2	0.01
Ae. lineatopennis	0	0	0	0	0	0	0	0	3	0.04	3	0.01
M. annulifera	14	0.3	11	0.3	160	4.2	652	11.6	42	0.6	879	3.6
M uniformis	5	0.1	5	0.1	51	1.3	124	2.2	61	0.9	246	1.0
M. crassipes	0	0	0	0	0	0	0	0	2	0.03	2	0.01
Ar. subalbatus	94	2.1	267	7.3	105	2.7	245	4.4	151	2.2	862	3.5

TABLE 39. MONTHWISE INDOOR RESTING DENSITY (♀♀ /MAN HOUR) OF CX. QUINQUEFASCIATUS IN NFCP AND VCRC AREAS

YEAR	1980	1981		1982		1983		1984		1985	
MONTH	Pre-control	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC
JAN	49.5	55.4	32.4	48.2	53.5	100.6	18.3	93.1	10.5	56.6	3.0
FEB	45.5	43.2	41.9	51.8	52.1	87.1	15.0	65.4	4.5	50.4	5.4
MAR	51.3	18.9	26.9	66.0	31.4	36.6	8.0	48.2	4.9	32.8	3.6
APR	46.5	27.0	12.4	26.9	7.9	25.0	3.9	28.2	2.5	15.7	0.8
MAY	53.5	23.2	10.3	20.9	6.2	11.2	1.3	21.4	1.6	8.0	1.0
JUN	63.3	24.0	2.8	14.8	4.4	4.8	1.9	18.5	0.5	19.1	0.9
JUL	61.5	82.9	19.3	21.3	8.3	8.1	5.6	16.1	0.9	50.7	7.8
AUG	57.0	63.3	37.9	38.7	14.7	40.0	14.7	37.4	3.6	47.5	11.4
SEP	65.5	97.3	30.0	33.1	9.4	61.5	11.9	37.5	2.8	70.3	11.9
OCT	11.5	99.3	20.5	81.0	9.6	37.2	4.6	41.5	2.9	36.8	10.9
NOV	85.5	60.7	31.0	57.9	16.3	57.8	6.3	55.4	3.9	42.9	7.1
DEC	67.0	79.5	33.4	78.7	18.2	48.3	7.9	36.4	4.6	73.2	16.6
Annual Average	54.8	55.7	25.0	44.0	17.0	43.2	8.3	41.6	3.6	41.4	6.9

TABLE 49. AREA, ZONE AND YEARWISE INDOOR RESTING DENSITY ($\overset{oo}{++}$ /MAN-HOUR) OF CX. QUINQUEFASCIATUS IN NFCP AND VCRC AREAS

Fixed catching stations	Resting density ($\overset{oo}{++}$/man-hour)				
	1981	1982	1983	1984	1985
KURICHIKUPPAM	27.8	51.0	55.3	66.7	39.5
MUTHIALPET	106.0	45.7	43.1	35.3	46.4
VOC NAGAR	34.5	35.4	31.2	22.9	38.1
ZONE - 2 (NFCP)	55.7	44.0	43.2	41.6	41.4
KARUVADIKUPPAM	11.8	5.5	4.9	2.4	1.8
SARAM	27.6	25.5	9.5	3.3	6.8
JEEVANANDAPURAM	12.3	7.3	7.6	2.6	6.5
ZONE - 3	17.4	12.8	7.3	2.8	5.0
KOSAPALAYAM	28.0	37.8	10.3	3.8	13.0
GOVINDASALAI	38.7	24.1	22.0	10.3	19.5
ZONE - 4	33.5	31.0	16.2	7.0	16.3
NELLITHOPE	32.6	14.6	5.9	1.9	3.0
MUDALIARPET	14.6	7.3	4.4	1.8	3.3
KEERAPALAYAM	32.4	14.7	8.4	1.2	6.2
THENGATHITTU	9.7	5.4	2.0	1.2	0.6
VANARAPET	24.4	9.5	5.9	2.0	8.5
VAMBAKEERAPALAYM	44.1	48.4	22.0	14.8	17.0
ZONE - 5	26.1	16.6	8.1	3.8	6.5
SUBBIAH NAGAR	44.5	23.7	9.1	3.8	6.0
REDDIAR PALAYAM	13.6	6.2	2.1	0.8	3.4
NAINARMANDAPAM	16.9	7.7	2.0	0.8	1.0
ZONE - 6	25.0	12.6	4.4	1.8	3.4
VCRC	25.0	17.0	8.3	3.6	6.9

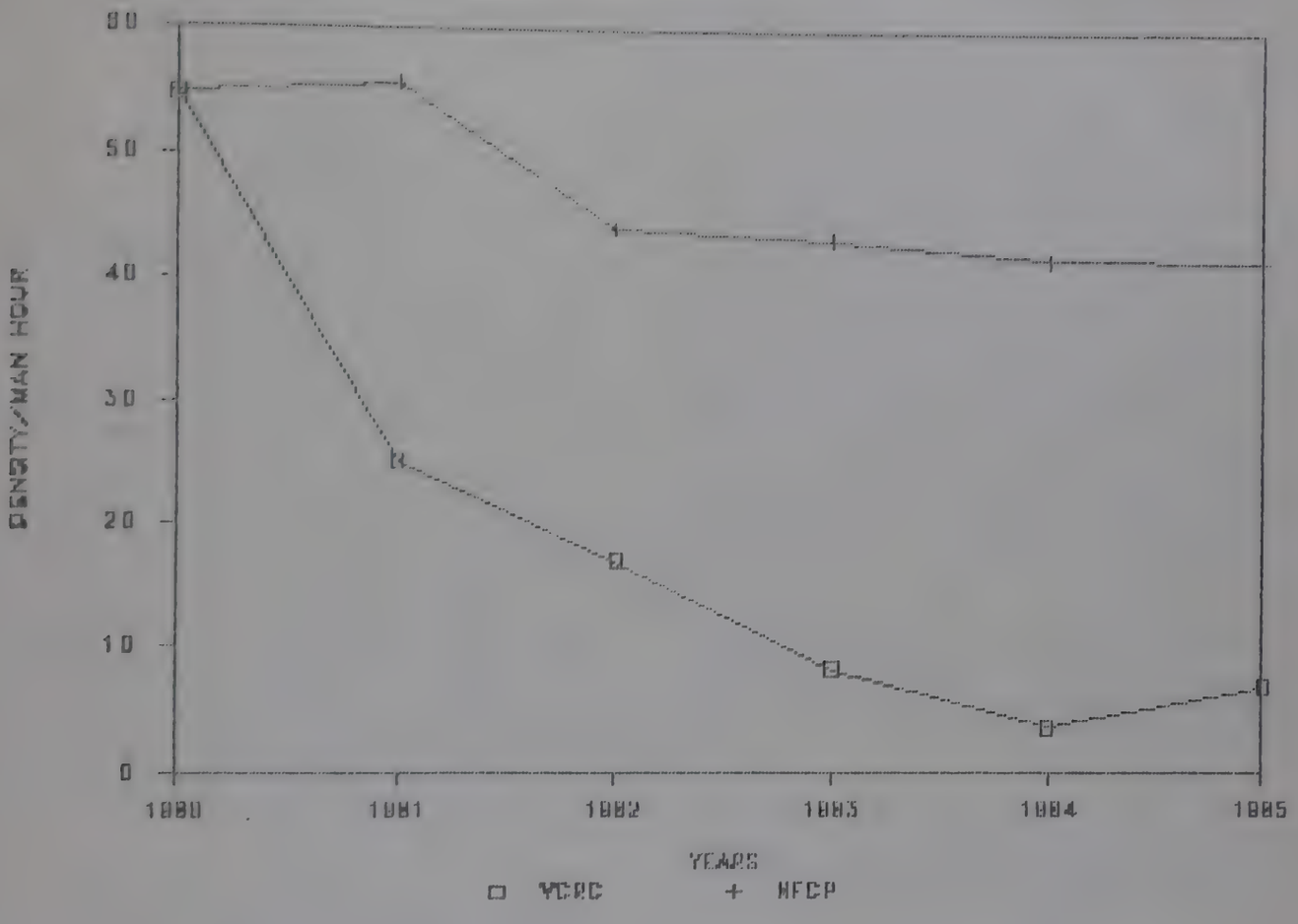

FIGURE 50. INDOOR RESTING DENSITY (♀♀/MAN-HOUR) OF CX.QUINQUEFASCIATUS IN NFCP AND VCRC AREAS

from 33.5 (1981) to 7.0 (1984) and Zone 6 had a comparatively lower density of 25.0 (1981) to 1.8 (1984) (Table 40). This is mainly due to the fact that in NFCP areas routine larvicidal methods were used whereas in VCRC areas IVM strategy was implemented very rigorously.

Zone 4 continued to have relatively higher density mainly because a large swamp was created due to blocking of a drain for three years. During 1984 and 1985 the breeding habitat was further increased by converting a L drain into covered U drain where water hardly flowed. Breeding in this drain could not be checked due to its peculiar construction. Comparatively higher mosquito density prevailed in Vambakeerapalayam in Zone 5 since it is situated near the Thengathittu lagoon in which control measures were restricted to approachable pockets and were not always effective.

Monthwise reduction in resting density was calculated by comparing pre control density with the resting density during different years and presented in Table 41.

During the entire study period a total of 69,760 indoor resting mosquitoes were dissected to determine the following parameters.

Parous rate:

Parity status of indoor resting vector mosquitoes was studied to monitor the age structure which reflects the efficiency of the control programme. The fluctuations in the parous rate was minimal and is shown in Table 42. The fairly stable parous rate observed indicate minimum fluctuations in the efficacy of control operations.

Infection rate:

There was no particular trend in the infection rate during different years and this is because vector control measures alone are not expected to have much impact on the infection rate in mosquitoes. There was only minor variations in the infection rates over the five years (Table 43).

Infectivity rate:

Infectivity rate of indoor resting mosquitoes was also monitored. The infectivity rate was high in 1981 and it correlated with parous rate which was also high in 1981. Infectivity rate was low in the subsequent years when compared to 1981 (Table 44).

6.1.3. Night Biting density (females/man hour) of *Cx. quinquefasciatus*:

The biting density in VCRC controlled zones was maintained at low level throughout the control period. Density being very low, monthly fluctuations were not marked in VCRC areas (Table 45). Contrary to this in NFCP areas as the density was not reduced, wide fluctuation in density between months was observed. Density in NFCP and VCRC areas was generally low during summer months and high during monsoon and post monsoon period. The biting density was high in zones I & II (NCFP). The density in zone I ranged from 2.7 in 1984 to 9.7 in 1981 and in zone II it ranged from 6.3 in 1982 to 16.3 in 1985. It ranged from 0.3 in 1984 to 1.5 in 1981 in zone III, 0.4 in 1984 to 2.4 in 1982 in zone IV and 0.3 in 1982 to 1.3 in 1981 in zone V. During 1983, 1984, 1985 biting density was less than 1 per man hour in all VCRC zones (Table 46).

The average biting density was reduced from pre control density of 15 per man hour in 1980 to 10.1 per man hour in 1981 in NFCP areas and to 1.7 in VCRC controlled areas. Density in VCRC areas was markedly less than that of NFCP areas throughout 5 years (Fig 51). The average biting density in VCRC areas showed declining trend till 1984 and only slightly increased in 1985. However, the average density in NFCP areas showed decrease until 1982 and thereafter there was an increase to a peak of 9.9 in 1985 (Table 46). During the entire study period a total of 12, 449 night biting mosquitoes were dissected for determining parous, infection and infectivity rates.

The parous rate of biting mosquitoes was high in VCRC areas when compared to that of NFCP areas except in 1985 (Table 47). The infection rate in biting mosquitoes ranged from 4.8 in 1982 to 13.4 in 1985 for NFCP areas and from 6.0 in 1985 to 11.0 in 1984 for VCRC areas (Table 48).

The infectivity rate in NFCP areas ranged from 0.2 in 1981 to 0.9 in 1985 and in VCRC areas

TABLE 41. *PERCENTAGE REDUCTION IN RESTING DENSITY OF Cx.quinquejasciatus IN VCRC & NFCP AREAS*

Month	1981		1982		983		1984		1985	
	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC
JAN	-11.9	34.5	2.6	-8.1	-103.2	63.0	-83.1	78.8	-14.3	93.9
FEB	5.1	7.9	-13.8	-14.5	- 91.4	67.0	-43.7	90.1	-10.8	88.1
MAR	63.2	47.6	-28.7	38.8	28.7	84.4	6.0	90.4	56.1	93.0
APR	58.1	73.3	42.2	83.0	46.2	91.6	59.4	94.6	66.2	90.3
MAY	56.6	80.7	39.1	88.4	79.1	97.6	60.0	97.0	85.0	98.1
JUN	62.1	95.6	76.6	93.0	92.4	97.0	70.8	99.2	69.8	98.6
JUL	-54.8	68.6	65.4	86.5	86.8	90.9	73.8	98.5	17.6	87.3
AUG	-11.1	33.5	52.1	74.2	29.8	74.2	54.4	93.7	16.7	80.0
SEP	-48.5	54.2	49.5	85.6	6.1	81.3	42.7	95.7	-7.3	81.8
OCT	-763.4	-78.0	-604.3	16.5	-223.5	60.0	-260.9	74.8	-220.0	5.2
NOV	29.0	64.9	32.3	80.9	52.4	92.6	55.2	96.4	49.8	91.7
DEC	-18.7	30.1	-17.5	72.8	27.9	88.2	45.7	93.1	-9.5	75.2
ANNUAL AVERAGE	-1.6	54.4	19.7	69.0	21.2	84.9	24.1	93.4	24.5	87.4

TABLE 42. MONTHWISE PAROUS RATE (%) OF INDOOR RESTING *Cx. quinquefasciatus* FROM NFCP & VCRC AREAS

MONTH	Parous rate									
	1981		1982		1983		1984		1985	
	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC
JAN	52.0	61.8	57.2	51.9	54.8	55.5	52.9	50.7	49.2	39.0
FEB	62.4	56.9	61.5	53.3	48.8	59.5	51.2	54.6	62.0	43.9
MAR	72.6	59.4	59.4	63.0	58.0	61.6	56.3	52.6	51.3	41.0
APR	62.5	60.1	56.6	51.1	58.7	56.0	56.4	66.5	49.5	57.6
MAY	52.6	49.4	54.1	43.4	61.3	62.7	56.0	41.5	56.9	44.4
JUN	42.9	46.1	48.5	37.4	51.7	44.9	35.5	36.4	41.3	41.9
JUL	56.6	45.7	49.3	47.0	41.4	51.6	44.6	36.1	44.9	37.9
AUG	69.1	58.0	47.3	45.2	48.4	42.1	56.7	51.4	57.9	45.3
SEP	61.4	69.6	49.1	46.8	57.5	56.0	51.9	52.3	42.5	50.0
OCT	66.7	59.3	48.8	52.0	66.7	57.0	57.3	56.1	65.2	47.9
NOV	76.1	63.3	49.8	50.0	61.3	51.6	51.3	53.1	54.2	52.0
DEC	67.1	64.0	51.5	50.7	55.5	57.4	54.6	54.4	64.2	51.5
Annual Average	**63.1**	**59.6**	**52.6**	**51.0**	**56.0**	**54.3**	**52.8**	**52.5**	**54.1**	**47.3**

TABLE 43. MONTHWISE INFECTION RATE (%) OF INDOOR RESTING *Cx. quinquefasciatus* FROM NFCP AND VCRC AREAS

MONTH	Infection rate									
	1981		1982		1983		1984		1985	
	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC
JAN	14.5	11.9	16.2	15.6	15.0	12.4	13.1	9.1	15.1	8.9
FEB	17.4	12.4	18.3	12.1	10.7	15.4	16.5	9.8	20.0	8.6
MAR	31.3	14.6	15.1	17.0	20.1	15.2	16.5	10.8	16.9	12.4
APR	21.3	13.3	14.3	12.8	22.6	13.5	14.5	14.6	16.6	12.1
MAY	12.3	13.2	15.4	12.3	20.6	25.5	19.5	9.6	22.2	8.6
JUN	13.7	9.1	18.8	8.5	21.8	16.0	14.5	13.6	20.2	9.5
JUL	12.5	11.8	17.9	13.6	20.0	15.8	23.9	9.7	17.0	11.5
AUG	14.4	13.5	13.2	12.1	16.3	16.0	17.6	14.2	16.9	11.9
SEP	13.1	14.4	17.5	12.1	21.5	16.8	18.0	11.0	12.8	10.2
OCT	11.5	11.6	16.5	13.0	22.7	18.1	16.7	11.3	25.8	10.6
NOV	13.9	11.9	13.0	12.0	30.5	16.9	23.4	13.0	13.8	9.4
DEC	13.7	14.9	22.1	13.0	20.7	11.6	15.5	11.9	19.5	14.6
Annual Average	15.1	13.1	16.4	13.3	20.3	15.2	17.2	11.2	17.9	11.4

TABLE 44. MONTHWISE INFECTIVITY RATE (%) OF INDOOR RESTING *Cx. quinquefasciatus* FROM NFCP AND VCRC AREAS.

MONTH	Infectivity rate									
	1981		1982		1983		1984		1985	
	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC
JAN	1.2	1.50	0.2	0.40	0.7	1.20	0.3	0.70	0.8	0.00
FEB	3.5	0.60	0.4	0.30	0.5	0.90	0.9	0.50	0.5	0.50
MAR	1.9	1.10	0.2	0.90	1	1.60	1.3	0.30	1.3	1.00
APR	1.2	0.40	0	0.50	0.3	1.50	1.3	1.40	1.1	0
MAY	0.9	0.50	0	0.20	0	0	1	0	0	0
JUN	0	0	0.4	0	1.2	0	0.3	0	0	0
JUL	0	0.40	0.5	0.30	0	0.20	1.7	0	0.7	0.80
AUG	1.1	1.10	1.2	1.30	0.60	0.50	0.4	1.00	1	0.60
SEP	1.1	0.90	1.3	0.50	1	1.00	1.8	0.80	0.2	0.70
OCT	0.7	1.00	0.5	1.10	1.1	0.80	1.3	0.40	2	0.60
NOV	1	0.80	0.2	0.7	1.2	0.20	0.4	0	1.2	0.30
DEC	0.7	0.30	1.1	0.60	1.2	0.60	0.7	0.50	1.5	0.40
Annual average	**1.16**	**0.83**	**0.53**	**0.60**	**0.79**	**0.83**	**0.96**	**0.55**	**0.90**	**0.5**

TABLE 45. MONTHWISE NIGHT BITING DENSITY ($\frac{00}{++}$/MAN HOUR) OF CX.QUINQUEFASCIATUS IN NFCP AND VCRC AREAS.

YEAR	1981		1982		1983		1984		1985	
MONTH	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC
JAN	11.9	1.7	5.2	5.4	7.5	0.8	11.6	0.4	5.9	0.4
FEB	9.5	2.1	7.0	2.5	4.4	0.8	5.9	0.3	5.7	0.7
MAR	4.7	0.6	6.5	1.6	1.9	0.3	5.8	0.2	4.9	0.1
APR	8.6	0.8	0.9	0.9	1.8	0.0	2.8	0.2	3.8	0.0
MAY	11.9	0.4	0.5	0.2	0.6	0.0	1.5	0.0	7.2	0.0
JUN	6.1	0.1	1.5	0.1	1.4	0.2	2.3	0.1	5.0	0.1
JUL	12.3	2.7	3.8	0.3	3.0	0.3	2.7	0.1	21.4	0.4
AUG	9.6	3.1	5.3	0.2	7.8	0.3	7.0	0.4	13.3	1.3
SEP	8.8	1.9	4.0	0.2	11.0	0.6	8.5	0.6	13.3	1.8
OCT	23.0	2.7	4.7	0.4	6.3	0.7	6.8	1.0	12.4	1.5
NOV	2.3	0.5	8.3	1.0	9.7	0.7	4.5	0.3	10.1	1.4
DEC	3.8	1.3	9.7	0.8	3.5	0.6	7.3	0.5	12.3	0.6
ANNUAL AVERAGE	10.1	1.7	4.8	1.1	4.9	0.4	5.5	0.3	9.9	0.7

TABLE 46. AREA, ZONE AND YEARWISE NIGHT BITING DENSITY (♀♀/MAN-HOUR) OF CX. QUINQUEFASCIATUS IN NFCP & VCRC AREAS

STATION	ZONE	Night biting density				
		1981	1982	1983	1984	1985
S.E. Bouleward	1	9.7	3.2	3.2	2.7	2.8
Muthialpet	2	10.5	6.3	6.6	8.3	16.3
NFCP		10.1	4.8	4.9	5.5	9.9
Karuvadikuppam	3	1.5	0.5	0.4	0.3	0.5
Kosapalayam	4	2.2	2.4	0.4	0.4	0.9
Mudaliarpet	5	1.3	0.3	0.4	0.4	0.8
VCRC		1.7	1.1	0.4	0.3	0.7

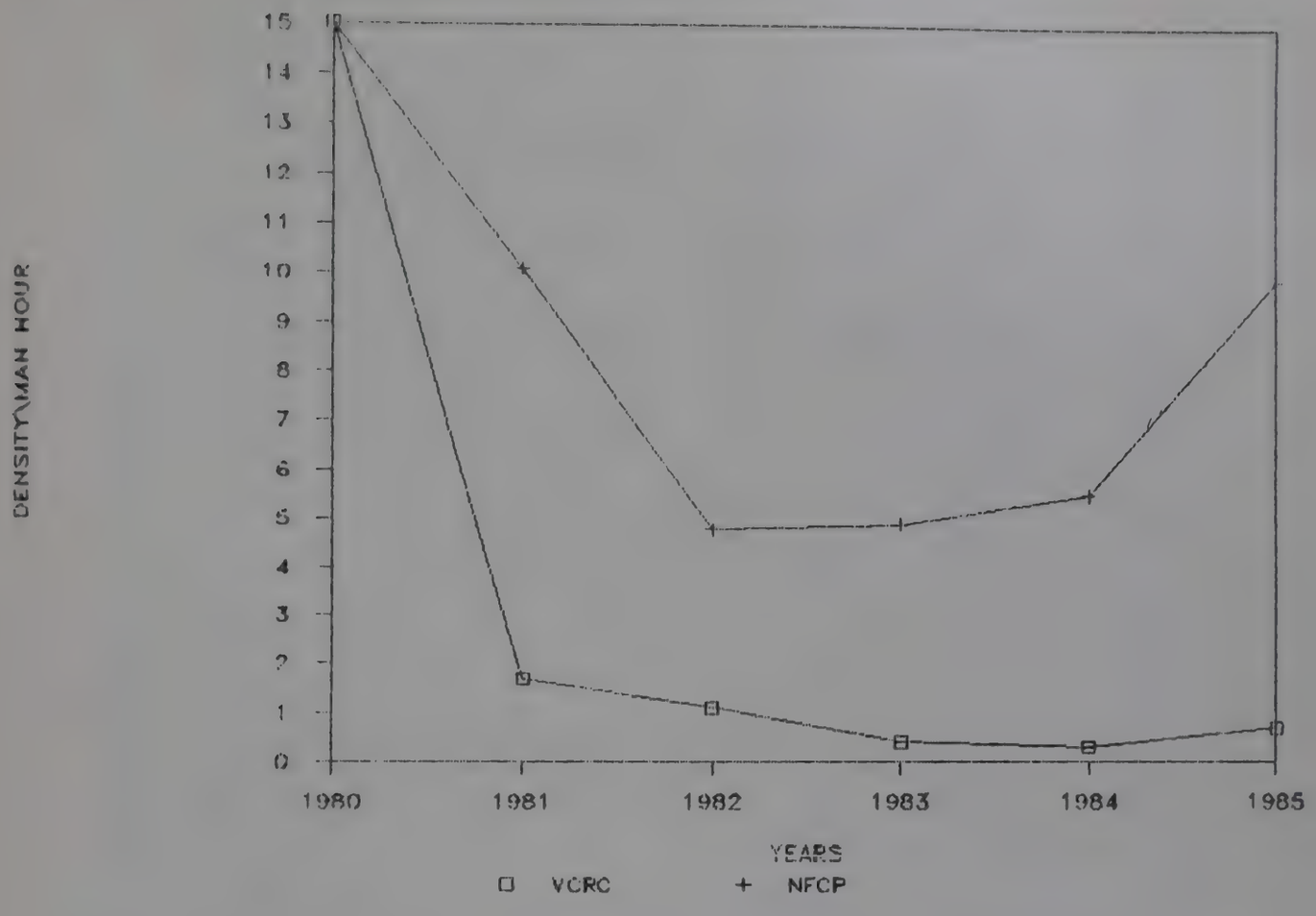

FIGURE 51. NIGHT BITING DENSITY (♀♀/MAN-HOUR) OF CX.QUINQUEFASCIATUS IN NFCP AND VCRC AREAS

TABLE 47. MONTHWISE PAROUS RATE (%) OF NIGHT BITING *Cx. quinquefasciatus* IN NFCP & VCRC AREAS.

Month	Parous rate									
	1981		1982		1983		1984		1985	
	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC
JAN	43.1	50.7	39.0	39.1	32.8	56.0	40.3	46.7	72.6	60.0
FEB	44.3	52.7	33.3	49.5	45.3	35.7	40.7	81.8	68.6	62.5
MAR	42.3	68.2	39.4	46.4	53.4	42.9	39.1	42.9	60.2	75.0
APR	47.1	57.1	38.5	61.1	50.0	100.0	53.0	28.6	60.0	-
MAY	20.3	75.0	33.3	75.0	42.9	-	47.8	-	65.1	-
JUN	35.4	80.0	48.6	50.0	39.0	57.1	29.1	66.7	66.4	20.0
JUL	39.3	52.5	34.2	71.4	35.6	66.7	29.7	33.3	62.3	50.0
AUG	35.7	54.6	40.5	75.0	35.3	44.4	38.3	70.0	67.2	48.3
SEP	44.5	47.1	36.7	28.6	43.3	44.0	36.8	65.0	57.8	57.1
OCT	42.6	57.5	39.8	50.0	44.1	52.0	32.3	48.7	58.4	53.6
NOV	64.3	60.0	27.3	59.5	27.7	64.0	35.8	44.4	52.5	50.9
DEC	49.6	69.5	27.6	72.2	52.4	54.6	48.6	68.4	62.8	80.0
Annual average	40.2	55.9	34.4	48.9	39.3	51.1	39.3	57.0	61.9	55.3

TABLE 48. MONTHWISE INFECTION RATE (%) OF NIGHT BITING *Cx. quinquefasciatus* IN NFCP AND VCRC AREAS

Month	1981		1982		1983		1984		1985	
	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC
JAN	10.64	13.33	10.57	5.67	3.33	12.00	5.04	13.33	22.64	10.00
FEB	5.26	5.41	3.57	7.69	14.15	7.14	7.14	9.09	16.79	4.17
MAR	6.31	4.55	5.81	3.57	6.90	7.14	4.60	0	15.25	0
APR	6.31	7.14	3.85	2.78	9.52	0	3.03	0	11.11	0
MAY	4.27	0	0	25.00	7.14	0	6.52	0	13.33	0
JUN	4.08	20.00	2.86	0	9.76	28.57	12.73	0	6.72	0
JUL	3.37	7.38	6.14	7.14	6.85	0	10.94	33.33	8.42	7.14
AUG	2.17	10.00	5.56	0	6.95	0	6.22	10.00	9.09	1.67
SEP	6.22	7.35	4.17	0	6.03	4.00	7.84	15.00	11.88	7.94
OCT	5.49	11.67	1.77	0	17.76	16.00	6.71	8.11	16.15	5.80
NOV	0	10.00	3.54	13.51	6.93	16.00	4.72	22.22	15.14	7.02
DEC	9.73	16.95	4.48	13.89	8.33	0	13.14	10.53	20.64	12.00
Annual average	5.7	9.5	4.8	6.8	8.2	9.0	7.1	11.0	13.4	6.0

it ranged from 0.6 in 1982 and 1985 to 2.1 in 1983 (Table 49).

6.1.4. All night biting collections:

Annual biting rate (estimated number of mosquitoes biting one man in one year) was calculated from the data from all night biting collections. The annual biting rate was 26,561 in the precontrol period (1979–80) and was reduced to 8,600 in 1981 which declined further in the subsequent years reaching a minimum of 1,662 in 1984. However, the annual biting rate had increased to 3,623 in 1985 (Table 50) (Fig. 52). The percentage reduction in man-vector contact ranged from 67.6 in 1981 to 93.7 in 1984 (Table 51).

The parous rate of biting mosquitoes ranged from 48.8 in 1981 to 57.2 in 1982. Only 4.7% of the biting population survived to attain the parity status of 3D and above, which is an important factor in the dynamics of transmission of disease.

The infection and infectivity rates fluctuated, the infection rate ranged from 3.9 in 1985 to 10.6 in 1983 and infectivity rate ranged from 0.43 in 1985 to 1.51 in 1983. The annual transmission index (Beye and Gurian 1960) which was 456.84 in 1979–80 dropped to 33.79 in 1982 (Table 52) and (Fig 52).

The risk of infection index (DeMeillon *et al*, 1967) from pre control value of 0.058 in 1979–80 was brought down to 0.0030 in 1984 (Table 53) and (Fig 52)

6.2. Parasitological Evaluation:

The impact of vector control operations was assessed not only by the declining density of the vector and the resultant fall in the transmission index for filariasis but also by measuring the mF status of the population particularly in the younger age groups.

A night blood survey was carried out in 1981 to obtain data on precontrol microfilaraemia and a second survey in 1986, after the project was completed.

There was no bias in the sampling procedures adopted during 1981 and 1986 surveys. However, an attempt was made to follow up as many persons as possible in 1986 from among those surveyed during 1981.

Similar methodology was adopted in both the surveys. Approximately 20c.mm. blood was collected from each person by finger prick method between 8.00 p.m and midnight and standard procedures were adopted for staining and examining the slides.

6.2.1. Precontrol microfilaraemia (1981)

Night blood samples from 24,946 people were collected constituting 9.16% of the population. The age wise and sexwise data on microfilaria rates are summarized in Table 54. More than 46% of the samples were from the age groups less than 20 years conforming to the demographic pattern of the population of Pondicherry. However, uniform sampling size in each age group was not practicable. The youngest age group (0–5 years) could not be sampled in sufficient numbers because of the reluctance of parents to allow blood collection from them.

Out of 24,946 persons examined 2,099 were found to be positive for microfilaria giving an mF rate of 8.41%. The highest mF count was 280. The median microfilaria density (MFD 50) was 4.48 (Table 54). Though the mF rate of the whole population was 8.41, it varied between 1.28 and 16% in different areas (Table 55). A zone wise analysis of the mF rates showed that zone 1 has the lowest mF rate (5.69%) and zone 2 and 3 have higher rates (Table 55). When mF rates of different areas were compared, it was found that in areas where poor sections of the society live, the mF rate was very high. Sexwise and agewise distribution of cases showed a slightly higher prevalence in the males above the age groups of 15–30 (Table 54) (Fig. 53). There was no significant difference in the mF rates of males and females in the age group of 0–14 years. This may be attributed to higher exposure to mosquito bites of males compared to females above the age of 14 years, since females are better clothed than males following puberty.

Infectivity potential of human population (Sasa & Zuzuki, 1974) was found to be 3.91% for whole Pondicherry. This figure was higher (4.18)

TABLE 49. MONTHWISE INFECTIVITY RATE (%) OF NIGHT BITING Cx.quinquefasciatus NFCP AND VCRC AREAS

Month	1981		1982		1983		1984		1985	
	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC	NFCP	VCRC
JAN	0.56	1.33	0	0.52	0	4.00	1.08	0	0	0
FEB	0	0	0	0	0.94	3.57	0	0	3.65	4.17
MAR	0	0	0	0	0	7.14	1.15	0	0.85	0
APR	0	0	0	0	0	0	0	0	0	0
MAY	0.71	0	0	12.50	0	0	2.17	0	0.51	0
JUN	0	0	0	0	0	0	0	0	0	0
JUL	0.56	0	0.88	0	0	0	1.56	0	0.40	0
AUG	0	2.73	0.79	0	0.53	0	0	5.0	1.01	0
SEP	0.48	2.94	0.83	0	0.35	0	0	0	0.94	0
OCT	0	0.83	0	0	0.66	4.0	1.22	2.70	1.66	1.45
NOV	0	0	0.51	0	0	0	0	22.22	0	0
DEC	0	5.08	0.34	2.78	2.38	0	1.14	0	1.16	0
Annual average	0.2	1.4	0.4	0.6	0.4	2.11	0.7	2.7	0.9	0.6

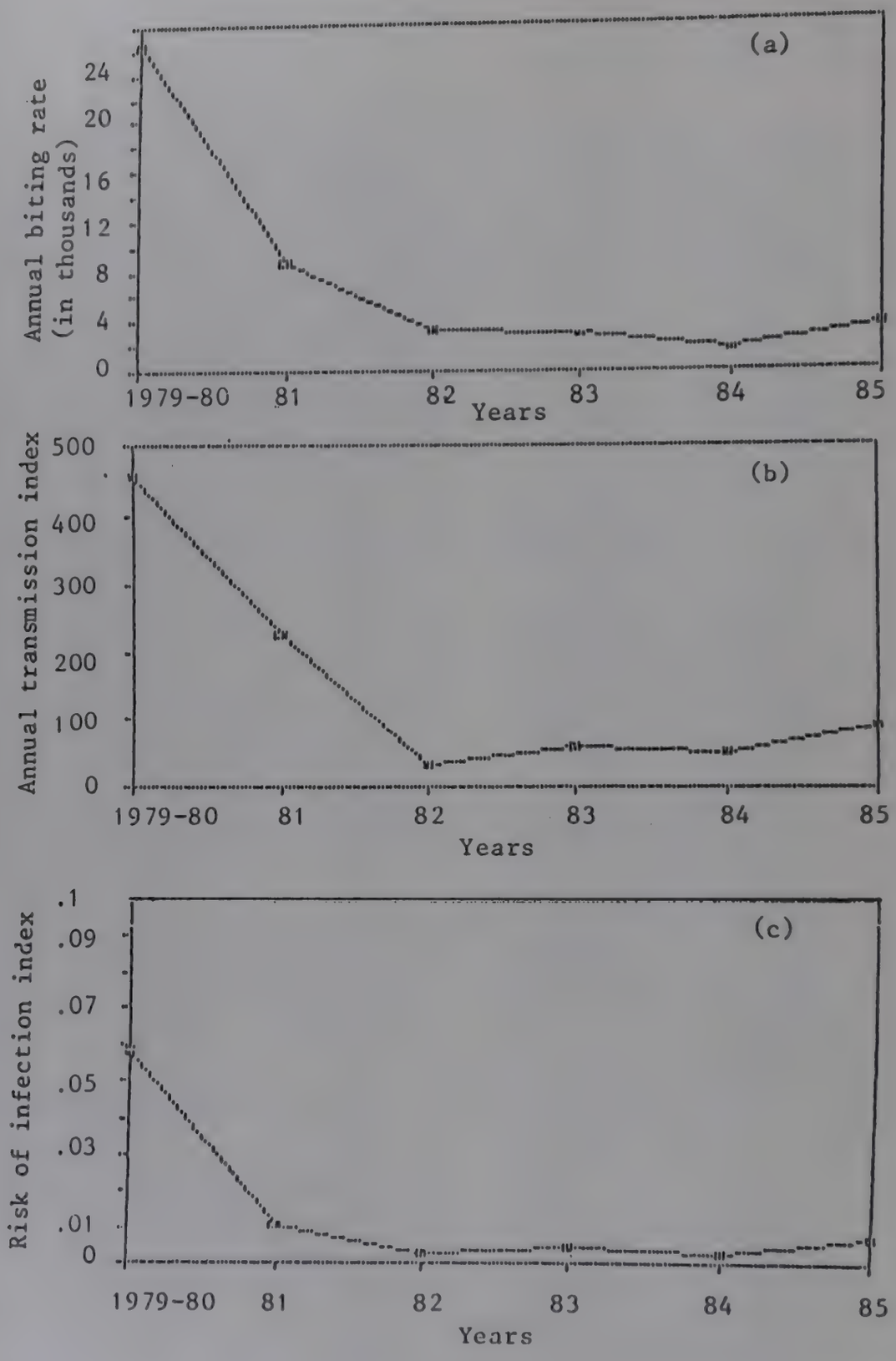

FIGURE 52. (a) ANNUAL BITING RATE (b) ANNUAL TRANSMISSION INDEX AND (c) RISK OF INFECTION INDEX IN DIFFERENT YEARS.

TABLE 50. MONTHLY AND ANNUAL BITING RATE OF Cx.quinquefasciatus DURING DIFFERENT YEARS(CALCULATED FROM ALL NIGHT BITING COLLECTION)

Month	1979-80 (Pre-control)	1981	1982	1983	1984	1985
January	1798	1023	356.5	263.5	279	155
February	1566	812	560	98	246.5	224
March	2619.5	279	372	186	139.5	31
April	1440	210	45	15	45	45
May	1860	449.5	155	15.5	0	15.5
June	975	120	90	75	120	45
July	2542	1891	341	201.5	62	248
August	2077	1255.5	46.5	189	108.5	713
September	2595	810	90	525	75	705
October	3704.5	697.5	170.5	325.5	372	604.5
November	1710	510	285	405	75	465
December	3673.5	542.5	682	635.5	139.5	372
Annual Biting rate	26561	8600	3194	2935	1662	3623

TABLE 51. THE % REDUCTION IN MAN VECTOR CONTACT DURING DIFFERENT MONTHS OF THE STUDY PERIOD.

Month	% reduction				
	1981	1982	1983	1984	1985
January	41.7	80.0	85.4	84.4	91.3
February	46.7	62.2	93.3	84.2	85.1
March	88.6	85.7	92.9	94.6	99.4
April	85.0	98.0	99.0	96.8	96.8
May	76.0	92.0	99.0	100	99.2
June	88.9	88.9	92.6	87.8	96.3
July	25.0	86.8	92.7	97.5	90.2
August	39.3	98.2	85.7	94.8	65.9
September	67.9	95.8	72.2	97.1	72.8
October	80.8	94.9	90.9	89.9	83.5
November	70.8	83.9	77.0	95.6	73.1
December	85.9	81.8	89.1	96.2	89.9
Average	67.6	87.9	88.5	93.7	85.4

TABLE 52. CHANGES IN ANNUAL TRANSMISSION INDEX (BEYE & GURIAN 1960) DURING DIFFERENT YEARS

	1979-80	1981	1982	1983	1984	1985
1. Estimated No.of mosquitoes biting a man in one year a	26560.5	8600	3193.5	2934.5	1662	3623
2. Proportion of mosquitoes infective b	0.0086	0.0057	0.0046	0.0067	0.0079	0.0079
3. Estimated No.of infective bites a man receives in one year	225	48.6	14.7	19.8	13.1	28.7
4. No.of infective larvae for infective mosquito c	2.0	4.61	2.30	2.93	3.72	3.13
5. Annual transmission index a x b x c	456.84	225.98	33.79	57.61	48.84	89.59

TABLE 53. CHANGES IN RISK OF INFECTION INDEX (DE MEILLON ET.AL. 1967) DURING DIFFERENT YEARS

		1979-80	1981	1982	1983	1984	1985
1. Total No.of mosquitoes dissected			4070	2168	2079	2292	3912
2. Total No.of parous mosquitoes			1780	858	833	938	2311
3. Biting density	a	6.02	1.95	0.73	0.69	0.38	0.88
4. Proportion parous to total biting	b	0.8025	0.4373	0.3958	0.4007	0.4092	0.5907
5. Proportion infective to total parous	c	0.012	0.0129	0.0117	0.0168	0.0192	0.0134
6. Risk of infection index	a x b x c	0.0580	0.0110	0.0034	0.0046	0.0030	0.0070

TABLE 54. AGE AND SEX WISE MF RATE DURING 1981

AGE GROUP	MALE NUMBER EXAM.	MALE NO. MF +'VE	MALE RATE (%)	MALE MFD-50	FEMALE NUMBER EXAM.	FEMALE NO. MF +'VE	FEMALE RATE (%)	FEMALE MFD-50	TOTAL NUMBER EXAM.	TOTAL NO. MF +'VE	TOTAL RATE (%)	TOTAL MFD-50
0-5	742	15	2.02	2.46	655	16	2.44	2.85	1397	31	2.22	2.76
6-8	1037	43	4.15	6.82	946	33	3.49	5.31	1983	76	3.83	5.66
9-11	1099	78	7.10	2.65	1086	78	7.18	6.00	2185	156	7.14	4.08
12-14	1274	117	9.18	4.79	1129	114	10.10	5.70	2403	231	9.61	4.81
15-19	1865	206	11.05	4.56	1662	164	9.87	4.76	3527	370	10.49	4.30
20-24	1498	185	12.35	5.87	1465	138	9.42	4.76	2963	323	10.90	4.92
25-29	1221	146	11.96	4.64	1285	118	9.18	5.39	2506	264	10.53	4.81
30-34	862	96	11.14	4.21	928	64	6.90	2.77	1790	160	8.94	3.57
35-39	639	46	7.20	3.59	826	71	8.60	3.71	1465	117	7.99	3.47
40-44	550	49	8.91	6.51	698	46	6.59	4.43	1248	95	7.61	5.20
45-49	456	41	8.99	4.82	609	44	7.22	3.77	1065	85	7.98	4.22
50-54	376	38	10.11	4.39	420	33	7.86	3.41	796	71	8.92	3.81
55-59	279	26	9.32	3.79	296	14	4.73	4.36	575	40	6.96	4.07
60-64	259	19	7.34	6.10	244	21	8.61	5.48	503	40	7.95	5.75
65-69	145	15	10.34	6.62	124	8	6.45	2.89	269	23	8.55	5.87
>=70	187	13	6.95	4.37	84	4	4.76	6.43	271	17	6.27	5.14
TOTAL	12489	1133	9.07	4.84	12457	966	7.75	4.71	24946	2099	8.41	4.48

TABLE 55. LEZ AND ZONE WISE MF RATES OF 1981 AND 1986

Zone No.	Lez No.	Lez Name	Sampled 1981	No. +ves	Mf rate	Sampled 1986	No. +ves	Mf rate	Increase/ decrease%	Level of Significance
I	1	Boulward I	252	14	5.56	216	11	5.09	-8.45	
	2	Boulward II	5109	291	5.70	5448	279	5.12	-10.18	
	Total		5361	305	5.69	5664	290	5.12	-10.02	P >0.05
II	3	Kurichikuppam	725	87	12.00	1040	91	8.75	-27.08	
	4	Valakulam	305	38	12.42	467	51	10.92	-12.08	
	5	Muthialpet	2049	215	10.54	3414	231	6.77	-35.77	
	6	V.O.C. Nagar	106	7	6.60	137	4	2.92	-55.76	
	17	Kumaragurupallam	121	10	8.26	180	22	12.22	+47.94	
	Total		3307	358	10.83	5238	399	7.62	-29.64	P <.001
VII	60	Ariyankuppam	851	58	6.81	1253	80	6.38	- 6.31	P >0.05
NFCP	TOTAL		9519	721	7.57	10155	769	6.33	-16.38	P <.001
III	7	Kottakuppam	1043	111	10.59	1293	87	6.73	-36.45	
	8	Karuvadikuppam	508	47	9.25	525	41	7.81	-15.57	
	9	Pethuchettipet	300	44	14.67	405	30	7.41	-49.49	
	10	Rajajinagar	87	4	4.60	140	9	6.43	-39.78	

Contd...

TABLE 55 continued

Zone No.	Lez No.	Lez Name	Sampled 1981	No. +ves	Mf rate	Sampled 1986	No. +ve	Mf rate	Increase/ Decrease %	Level of significance
	11	Tagore Nagar	190	18	9.47	298	24	8.05	-14.99	
	12	Lawspet	509	58	11.39	530	46	7.93	-30.38	
	13	Thattottukalapet	150	13	8.67	173	15	8.67	0	
	14	Saram	415	54	13.01	553	43	7.78	-40.2	
	15	Brindavanam	105	8	7.55	103	6	5.83	-22.78	
	16	Rainbow Nagar	115	7	6.09	90	8	8.89	+45.98	
	18	Venkata Nagar	142	6	4.23	295	7	2.37	-43.97	
	19	Jeevanandapuram	104	6	5.77	147	8	5.44	- 5.72	
	20	Pakkamudayanpet	100	16	16.00	102	7	6.86	-57.13	
	Total		3774	392	10.39	4704	331	7.04	-32.24	P<.001
IV	32	Nellithope	1566	149	9.50	2171	148	6.82	-28.21	
	33	Mudaliarpet I	891	76	8.53	1597	70	4.38	-48.65	
	34	Mudaliarpet II	702	71	10.11	1181	60	5.08	-49.75	
	35	Uppalam I	173	9	5.20	186	12	6.45	+24.04	
	36	Uppalam II	283	17	6.01	324	15	4.63	-22.96	

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TABLE 55 continued

Zone No.	Loc No.	Loc Name	Sampled 1981	No +ves	Mf rate	Sampled 1986	No +ves	Mf rate	Increase/ Decrease %	Level of significance
	37	Keerapalayam	190	24	12.63	266	12	4.51	-64.29	
	38	Natesan Nagar	90	1	1.11	100	5	5.00	+350.45	
	39	Thengathittu	307	21	6.84	595	14	2.35	-65.60	
	40	Vanarapet	713	101	14.17	1285	116	9.03	-36.27	
	41	Kolas Nagar	101	11	10.89	153	10	6.54	-39.94	
	42	Vembakeerapalayam	404	53	13.12	864	44	5.09	-61.20	
	Total		5422	533	9.83	8723	505	5.30	-41.00	P < .001
IV	21	Diango Nagar	101	2	1.98	118	3	2.53	+28.28	
	22	Kennedy Nagar	85	15	17.65	250	29	11.6	-34.28	
	23	Orleanpet	229	18	7.86	256	22	8.27	+ 5.22	
	24	Iyyanar Nagar	100	5	5.00	151	11	7.28	+45.60	
	25	Kosapalayam	1061	82	7.73	1415	106	7.49	- 3.10	
	26	Gathiyanagar	108	9	8.33	121	9	7.44	-10.68	
	27	Pettian Chatiram	190	23	12.11	437	44	10.07	-16.85	
	28	Mohan Nagar	78	1	1.28	208	14	6.90	+439.06	

Contd ...

TABLE 55 continued

Zone No	Lez No.	Lez Name	Sampled 1981	No +ves	Mf rate	Sampled 1986	No +ves	Mf rate	Increase/ Decrease %	Level of Significance
	29	Ellapillaichavadi	119	12	10.08	158	11	6.96	-30.95	
	30	Govindasalai	531	36	6.78	639	54	8.45	+24.63	
	Total		2602	203	7.80	3759	303	8.06	+ 3.33	P>0.05
VI	45	Delarshpet	355	35	9.86	631	27	4.28	-56.29	
	46	Kadirkamam	303	21	6.93	425	23	5.41	-21.93	
	47	Sokkabathampet	185	13	7.03	215	15	6.93	- 0.71	
	48	Mettupalayam	407	31	7.62	618	32	5.18	-32.02	
	49	Subbiah Nagar	376	29	7.71	667	57	8.55	+10.89	
	51	Reddiarpalayam	354	21	5.93	471	31	6.58	+10.96	
	52	Pavalakaranchavady	123	5	4.07	183	10	5.46	+34.15	
	53	Kamban Nagar	192	12	6.25	199	5	2.51	-59.84	
	54	Veemakoundanpalayam	423	29	6.78	646	43	6.66	- 1.78	
	56	Nainarmandapam	152	8	5.26	183	10	5.46	+ 3.80	
	57	Murungabakkam	572	40	6.99	779	29	3.72	-46.78	
	58	Kombakkam	182	6	3.30	257	5	1.95	-40.91	
	Total		3529	250	6.89	5274	287	5.44	-21.05	P<0.01
YANAM	TOTAL		15427	1378	8.93	22450	1427	6.35	-28.89	P<0.001
PONDICHERRY	TOTAL		24946	2099	8.41	34315	2196	6.34	-24.61	P<0.001

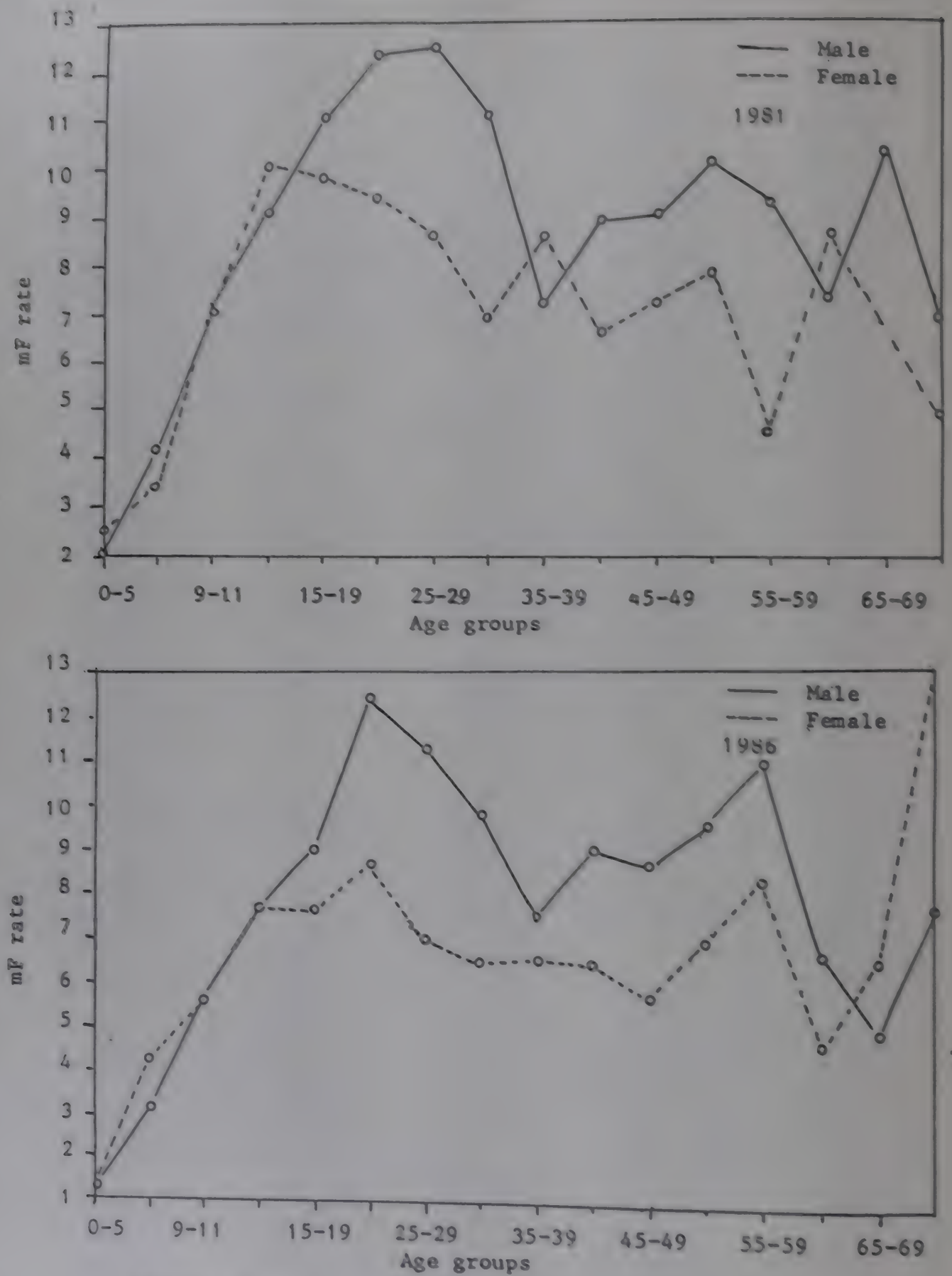


FIGURE 53. AGE AND SEXWISE DISTRIBUTION OF MF CARRIERS DURING 1981 AND 1986

in VCRC operated areas when compared to NFCP areas (3.46). Lower infective potential in NFCP Zones is due to better socio-economic conditions of the people residing in this area.

Incidence of microfilaraemia in Pondicherry:

The average annual incidence (Kimura *et al*, 1985) was calculated in the age group of 1–7 years, based on the assumption that there was no change in population size upto 7 years of age, using the formula.

Where I = annual incidence/1000 population
Ni = Number of positives at age i
Pi = population examined at age i

Incidence for Pondicherry as a whole was found to be 3.30 for 1000 population. When zonewise comparison was made it was found that the incidence in NFCP Zones was lower (3.2) than that of VCRC controlled Zones (3.62). Higher incidence was recorded in males (3.38) compared to females (2.97).

Since microfilaraemia in the age group 0–5 reflects intensity of transmission, mF rate in this age group is an important parameter in evaluating the effect of control measures. The mF rate in this age group was found to be 2.22 for whole Pondicherry. In VCRC controlled areas mF rate in this age group was 2.39% whereas in NFCP areas it was 1.84%.

The intensity of infection was measured by calculating MFD50 (Sasa, 1976) and is shown in Table 54. The age specific MFD50 closely follows the pattern of prevalence (mF rates) in different age groups.

Though the MFD 50 is an useful parameter to evaluate the impact of chemotherapy on microfilaraemia, it has got limited value in evaluating the effectiveness of vector control on filariasis control. Therefore, the mean microfilaria count which statistic encapsulates the reduction in both the prevalence and intensity of infection was calculated. It was 0.91 for whole of Pondicherry and 0.98 for VCRC zones and 0.80 for NFCP zones.

Both the mF rate and MFD 50 values are high in the age group 15–30, and therefore, this age group is the major source of infection to others. It may also be mentioned that this group is numerically dominant in the population.

Frequency distribution of microfilaria counts (density) in the population showed that fewer individuals have very high microfilaria densities while a large number of individuals have low microfilaria densities. One thrid of the population infected harbour three fourths of the microfilaria load in the population.

Since no attempt was made to clinically examine the population, only gross disease manifestations like elephantiasis of the limbs were recorded. Even with this limitation it was found that the disease rate was 0.27 percent.

6.2.2. Summary of Epidemiological analysis of 1981 survey data:

1. The pre-control mf-rate in Pondicherry was 8.41%.
2. Prevalence is the highest in young adults, and they are also the numerically dominant section of the infected population.
3. The age specific MFD 50 indicates that intensity is maximum in young adults.
4. The mean microfilaria count for Pondicherry was 0.91 and for VCRC zones 0.98 and for NFCP Zones 0.80.
5. The infected population in the age group of 15–30 years is likely to be the major source of transmission.
6. Thirty percent of infected people harbour 75.37% of the microfilariae.
7. No estimate was possible of the infected population who were amicrofilaraemic.

6.2.3. Post control microfilaraemia (1986):

In the 1986 survey 34,615 persons (11.16%) of the population were examined. A total of 2,196 were found to be positive for microfilaria giving an mF rate of 6.34%. Age and sex wise analysis of mF prevalence is summarized in Table 56. Age and sexwise prevalence of microfilaraemia showed similar pattern of distribution as observed in 1981.

TABLE 56. AGE AND SEX WISE MF RATE DURING 1986

AGE GROUP	MALE				FEMALE				TOTAL			
	NUMBER EXAM.	NO. MF +'VE	RATE (%)	MFD-50	NUMBER EXAM.	NO. MF +'VE	RATE (%)	MFD-50	NUMBER EXAM.	NO. MF +'VE	RATE (%)	MFD-50
0-5	1086	3	0.28	4.33	937	4	0.43	3.27	2023	7	0.35	3.14
6-8	1184	25	2.11	5.48	1075	34	3.16	4.27	2259	59	2.61	4.90
9-11	1386	64	4.62	5.07	1379	63	4.57	5.54	2765	127	4.59	5.25
12-14	1705	112	6.57	3.84	1656	111	6.70	4.34	3361	223	6.63	4.06
15-19	2471	196	7.93	3.84	2494	163	6.54	4.71	4965	359	7.23	4.21
20-24	1988	226	11.37	4.64	1982	150	7.57	3.99	3970	376	9.47	4.37
25-29	1548	158	10.21	4.69	1845	110	5.96	2.83	3393	268	7.90	3.70
30-34	1231	108	8.77	4.09	1444	78	5.40	3.55	2675	186	6.95	3.23
35-39	975	63	6.46	4.60	1292	71	5.50	3.37	2267	134	5.91	3.80
40-44	741	59	7.96	4.79	942	51	5.41	4.37	1683	110	6.54	4.52
45-49	660	50	7.58	6.48	819	38	4.64	3.57	1479	88	5.95	4.89
50-54	555	47	8.47	4.59	681	40	5.87	4.54	1236	87	7.04	4.48
55-59	413	41	9.93	4.20	482	35	7.26	3.50	895	76	8.49	3.92
60-64	370	21	5.68	3.74	363	13	3.58	5.65	733	34	4.64	4.53
65-69	231	9	3.90	2.27	217	12	5.53	3.35	448	21	4.69	2.98
>=70	269	18	6.69	5.72	194	23	11.86	2.71	463	41	8.86	3.32
TOTAL	16813	1200	7.14	4.37	17802	996	5.59	3.96	34615	2196	6.34	4.08

The MFD 50 calculated for the sample was 4.08. In NFCP areas MFD 50 was 3.85 which was lower than that of VCRC zones (4.43). The overall infectivity potential of human population to vector (Sasa, 1976) was found to be 2.84. The infectivity potential was 2.88 in VCRC areas and 2.76 in NFCP areas.

The mean microfilaria count for Pondicherry was 0.71 and for VCRC zones 0.71 and for NFCP zones it was 0.71.

Incidence of infection per thousand population (Kimura, *et, al*, 1985) for whole of Pondicherry was 1.27. Incidence for VCRC areas was 1.04 and for NFCP areas it was 1.76. The mF rate in 0–5 age group in NFCP area was found to be 0.65% whereas in VCRC areas it was 0.21% giving an overall MF rate of 0.35% for whole of Pondicherry.

6.2.4. Microfilaraemia in resurveyed people:

A total of 7,495 persons sampled in 1981 were also sampled in 1986. The age wise prevalence of mF rate among the resurveyed people is depicted in Table 57. Out of a total of 627 persons who were positive for microfilaraemia in 1981, 242 (38.6%) continued to be microfilaraemic in 1986. A majority of these persons (68.5%) who were mF positive in both surveys were residing in VCRC Zones.

Of the 6,868 people who were mF negative in 1981, 240 (3.5%) became positive for mF in 1986. Whether they acquired infection during the intervening period or whether they were already infected but were microfilariae negative at the time of sampling in 1981, is difficult to say.

Among the people surveyed both in 1981 and 1986, MFD50 was 4.49 in 1981 and 4.22 in 1986. The agewise analysis of MFD50 showed that the reduction was marked only in younger age groups.

6.2.5. Population movement in Pondicherry:

The movement of people from one area to another within Pondicherry and others who have come from outside Pondicherry was investigated.

Those who have not moved within last five years (after 1981) were taken to be permanent residents in the respective zones. Of 34,615 people surveyed, information on residence could be obtained from 33,285 people. A total of 12.8% people changed their residence during the five years from one area to other. A majority of these people however moved within Pondicherry.

Obtaining a correct picture of prevalence of microfilaraemia in a large population is beset with many difficulties and the mF rates obtained in the surveys in 1981 and in 1986 may be underestimates due to the following reasons:

1. Since only a single blood smear was examined, the individuals with very low microfilaraemia were likely to be missed.

2. The finger-prick blood smear method used is considerably less efficient than other methods like membrane-filtration and counting chamber etc. which are not practicable when doing large surveys. The VCRC is aware of these limitations and demonstrated experimentally that in a population with low mF density the prevalence estimated by membrane-filtration was five times that of estimated by blood smear technique. This relationship is similar to the findings of Southgate (1973). The decision not to use membrane-filtration was because of the demonstrated aversion of local people to venepuncture.

3. For production of a patent microfilaraemia a host must harbour at least one mated pair of adult worms. It is probable, however, that single infections and single-sex infection occur more commonly than infections with mated pairs. This occurs because the majority of mosquitoes carry very few infective larvae; they have a frequency distribution identical to that of worms in definitive hosts. Hence a majority of infections are likely to be amicrofilaraemic and could not be detected by blood smear technique.

4. Though blood samples were collected between 20.00—24.00 hr., a majority of the sample was collected between 20.00 — 22.00 hr. as the people generally go to sleep after 22.00 hr. Earlier studies on microfilarial periodicity for *W.bancrofti* (Rajagopalan *et al*, 1977) suggest that peak density occurs between 22.00 — 02.00 hr. For practical reasons most blood specimens were obtained before peak mF density was attained in the peripheral blood. In addition, shop-keepers, vendors and

TABLE 57. PREVALENCE OF MF RATE AMONG RESURVEYED PEOPLE

AGE GROUP	NO. RESURVEYED	POSITIVES 81	MFRATE 81	MFDSO 81	POSITIVES 86	MFRATE 86	MFDSO 86
6-10	507	13	2.56	2.98	21	4.14	6.60
11-13	797	37	4.64	5.38	46	5.78	3.46
14-16	852	59	6.92	4.95	39	4.58	4.61
17-19	779	83	10.65	4.58	62	7.96	3.06
20-24	819	97	11.84	4.40	77	9.40	3.60
25-27	628	75	11.94	4.20	51	8.12	4.58
30-34	619	67	10.82	5.40	50	8.08	5.77
35-37	523	45	8.60	3.06	26	4.97	3.19
40-44	482	36	7.47	2.98	22	4.56	2.85
45-49	421	33	7.84	3.77	23	5.46	4.27
50-54	364	27	7.42	3.33	18	4.95	5.67
55-59	266	24	9.02	4.26	21	7.89	3.74
60-64	178	15	8.43	3.22	9	5.06	5.77
65-69	130	7	5.07	4.00	6	4.35	9.50
70-74	70	5	7.14	3.00	8	11.43	5.50
>=75	32	4	7.69	5.00	3	5.76	2.00

patrons of local bars returned to their homes late in the evening and were not sufficiently rested for microfilarial density to have peaked at the time of blood collection. These factors will reduce the chances of detection of mF in their blood.

Therefore, the mF rates obtained during the surveys are underestimates due to reasons stated above. However, the surveys in 1981 and 1986 were subjected to similar sampling problems/ error and therefore valid comparison can be made.

6.2.6. Comparison of survey results 1981/1986 (Table 58)

1. The overall mf rate in Pondicherry was found reduced from 8.41% in 1981 to 6.34% in 1986. The fall in VCRC zones is statistically significant ($Z = 9.42$, $p = 0.0001$). The agewise analysis of mF rate shows that there was a general reduction in most age groups (Fig.54). The mF rate in 0–5 age group has been reduced from 2.22% in 1981 to 0.35% in 1986. In VCRC areas mf prevalence in the same age group was significantly reduced from 2.39% in 1981, to 0.21% in 1986.

2. The MFD 50 for whole of Pondicherry was reduced from 4.48 in 1981 to 4.08 in 1986.

3. The mean microfilaria count was found reduced from 0.98 in 1981 to 0.71 in 1986 from VCRC zones and from 0.8 to 0.71 for NFCP zones and from 0.91 to 0.71 for Pondicherry. (Table 58) The age wise change in mean microfilaria count for VCRC and NFCP zones are shown in Fig.55. The reduction in VCRC zones was well marked compared to NFCP zones.

4. Infectivity potential of humans to vector population was also reduced from 3.91 in 1981 to 2.84 in 1986 in whole of Pondicherry.

5. The incidence of microfilaraemia (Kimura *et al*, 1985) for whole of Pondicherry was reduced from 3.3 per 1000 population to 1.27 per 1000 population at the end of project period.

6.3. Clinical Picture of Filariasis in Pondicherry:

The clinical manifestations of bancroftian filariasis are known to vary in different areas (Hawking, 1976; Rao *et al*, 1977). Study of clinical manifestations is essential to understand the extent of disease problem. It is known that in early stages of the disease only acute manifestations appear intermittently. As the disease progresses chronic features become apparent. Though studies on clinical aspects are necessary for precise epidemiological assessment of Filariasis problem in an area, such studies were not carried out in Pondicherry.

Therefore, a disease survey was carried out during 1986 to study the prevalence and clinical spectrum. In earlier reports only gross clinical manifestations were recorded and actual clinical examination of the population was not carried out. The results of the first comprehensive filariasis disease survey ever conducted in Pondicherry are presented and discussed below.

The survey was carried out by door to door visits. A team of doctors visited all households between 5 and 10 p.m. in randomly chosen localities. All available persons were interviewed and clinically examined. History of chyluria and previous filarial diagnosis or treatment were recorded. During clinical examination both acute and chronic signs of filariasis were looked for. To maintain uniformity and minimize subjective error in diagnosis and recording, the doctors involved were given special training before the actual survey.

A total of 6,493 persons were clinically examined, of which 2,466 (38%) were males and 4,027 (62%) were females (Table 59). A higher percentage of females in the sample was unavoidable as the male members of the family went out in the evenings for various purposes. The majority of the sample was from the age below 20 years (54%), who are also the dominant age group in the population (50.7%). Out of 6493 persons examined, 428 (6.6%) persons were clinically positive for filariasis. The disease rate in males (13.7%) was significantly higher than that of females (2.3%) ($P<0.05$). Age and sex wise prevalence of disease is shown in Table 57. The disease prevalence was low in children below 14 years age, following which, age group wise increase of the disease was observed. The disease prevalence remained more or less constant above 55 years age.

Clinical spectrum of filariasis in Pondicherry is presented in Table 60. Manifestations related

TABLE 58. COMPARISON OF PARASITOLOGICAL SURVEY RESULTS DURING 1981 AND 1986

Parameters	VCRC			NFCP			PONDICHERRY		
	1981	1986	P.Value	1981	1986	P.Value	1981	1986	P.Value
No.Surveyed	15,427	22,460	-	9,519	12,155	-	24,946	34,615	-
No. +ve	1,378	1,427	-	721	769	-	2,099	2,196	-
MF Rate(%)	8.93	6.35	0.0001	7.57	6.33	0.0002	8.41	6.35	0.0001
MF Rate(0-5 Years)	2.39	0.21	0.0001	1.84	0.65	0.001	2.22	0.35	0.0001
MFD50	4.91	4.43	-	4.59	3.85	-	4.48	4.08	-
Mean mF count	0.98	0.71	-	0.80	0.71	-	0.91	0.71	-
Incidence	3.62	1.04	-	3.20	1.76	-	3.30	1.27	-
Infectivity potential of human population	4.18	2.88	-	3.46	2.76	-	3.91	2.84	-

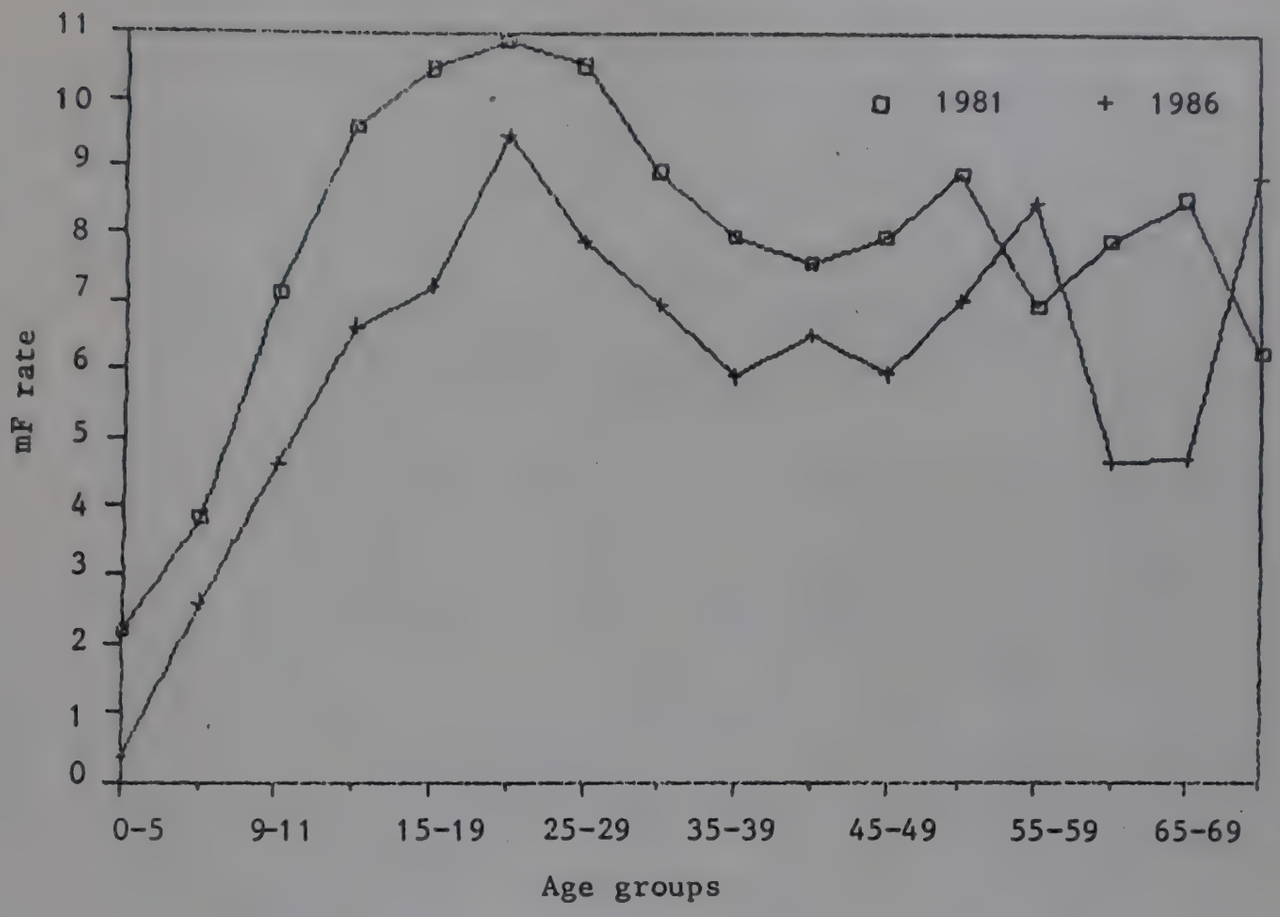
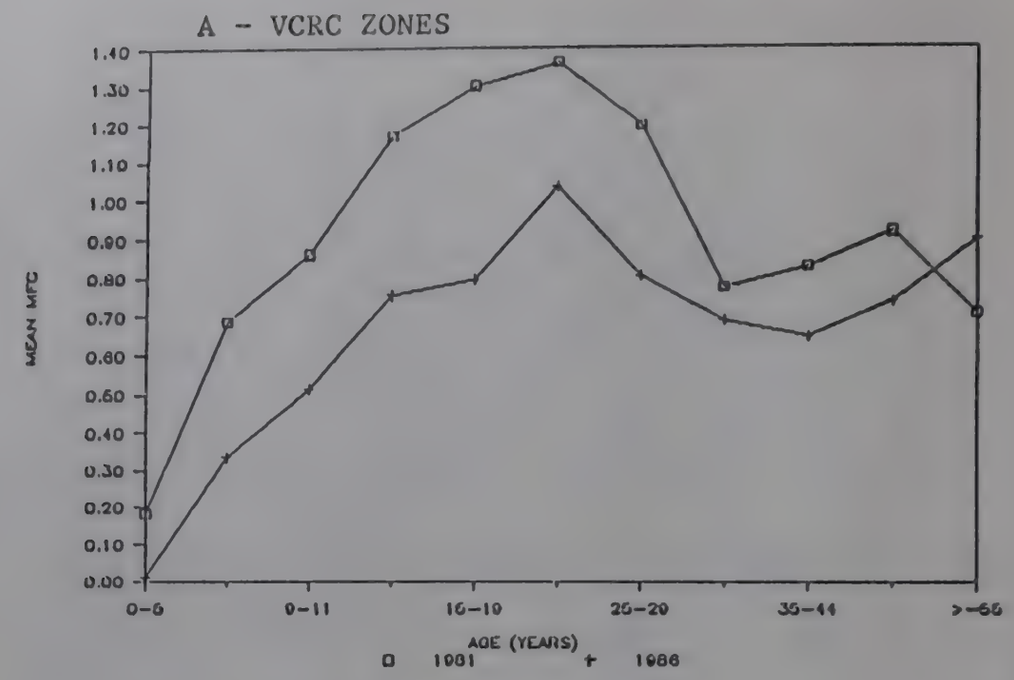


FIGURE. 54. AGEWISE COMPARISON OF MF RATES DURING 1981 and 1986



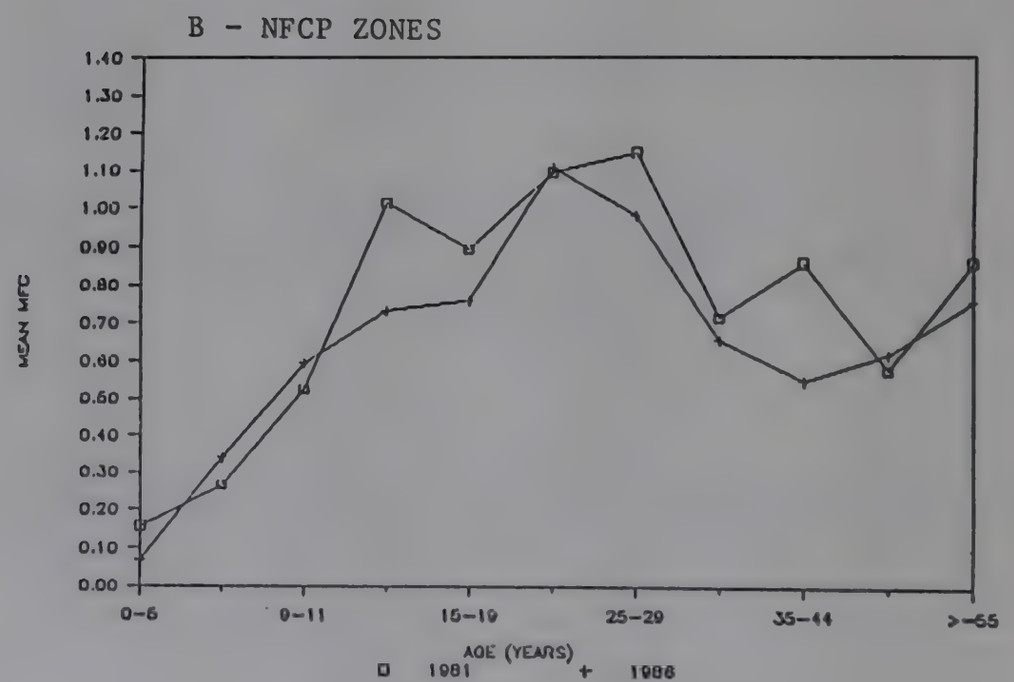


FIGURE 55. COMPARISON OF MEAN MICROFILARIAL COUNTS IN THE SURVEYED POPULATION (1981 and 1986) FOR VCRC AND NFCP ZONES.

TABLE 59. AGE AND SEXWISE DISTRIBUTION OF FILARIASIS DISEASE RATE.

Age groups (years)	Male		Female	
	Sample	Disease rate %	Sample	Disease rate %
0-4	333	0	356	0
5-9	473	0.63	539	0.93
10-14	421	2.38	606	0.66
15-19	289	7.27	505	1.19
20-24	171	15.21	421	0.71
25-29	134	23.88	351	2.28
30-34	121	26.45	243	2.47
35-39	89	30.34	233	2.58
40-44	86	29.07	184	7.07
45-49	79	39.24	150	4.67
50-54	62	59.68	119	5.88
55-59	66	48.48	106	7.55
60-64	61	47.54	82	7.31
≥ 65	81	39.51	132	8.33
Total	2466	13.67	4027	2.26

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TABLE 60. CLINICAL SPECTRUM OF FILARIASIS IN PONDICHERRY.

Clinical manifestations	MALE (Total: 337) No. +ve (%)	FEMALE (Total: 91) No. +ve (%)	BOTH SEXES (Total:428) No. +ve (%)
Filarial Fever	8 (2.4)	7 (7.7)	15 (3.5)
Lymphangitis	5 (1.5)	0	5 (1.2)
Thickened Lymphatic trunks	19 (5.6)	7 (7.7)	26 (6.1)
Funiculitis	32 (9.5)	-	-
Epididymoorchitis	41 (12.2)	-	-
Hydrocele			
Unilateral	230 (68.2)	-	-
Bilateral	63 (18.7)	-	-
Total	293 (86.9)	-	-
Lymphoedema			
Lower limbs	9 (2.7)	7 (7.7)	16 (3.7)
Upper limbs	0	1 (1.1)	1 (0.2)
Both limbs	0	1 (1.1)	1 (0.2)
Total	9 (2.7)	9 (9.9)	18 (4.2)
Elephantiasis			
Lower limbs	26 (7.7)	64 (70.3)	90 (21.0)
Upper limbs	1 (0.3)	1 (1.1)	2 (0.5)
Both limbs	2 (0.6)	10 (3.0)	12 (2.8)
Total	29 (8.6)	75 (82.4)	104 (24.3)
Lymph varix	11 (3.3)	1 (1.1)	12 (2.8)
Lymph scrotum	7 (2.1)	-	-
Lymphadenitis	233 (69.1)	38 (41.8)	271 (63.3)
Chyluria	49 (14.5)	30 (33.0)	79 (18.5)

to external genitalia were predominant among males. Hydrocele was the commonest clinical presentation among males accounting for 86.9% of diseased males. The other common manifestations among males were epididymo-orchitis and funiculitis. Elephantiasis of limbs was the predominant clinical presentation among females, which was detected in 82.4% of diseased females. Presentations like thickened lymphatic trunk and lymph varix were significantly higher in males compared to females ($P<0.05$). Among the diseased males and females, 69.1% and 41,8% respectively had associated lymphadenitis. Involvement of the inguinal nodes was most common in both males and females. Of the diseased persons 50.5% males and 40.7% females had inguinal adenitis.

It was found that 27 (8.00%) and 8 (8.8%) of diseased males and females respectively had only acute filarial manifestations. The predominant acute presentation in both males and females was thickened lymphatic trunk. Most of these cases had associated lymphadenitis. A majority of hydrocele cases (78.5%) were unilateral in nature and the rest bilateral. Among the unilateral hydrocele cases 48 (20.9%) patients had associated funiculitis or epididymo-orchitis involving the other testicle.

Majority of elephantiasis among both males and females had lower limb affected. Involvement of upper limb alone was rare. Few cases had both elephantiasis of mammae or external genitalia in females was detected in the survey. Majority of lymphodema cases also had lower limb involvement.

6.3.1. Clinical history:

Among the diseased people 9.8% males and 9.9% of females had associated history of chyluria. In males, history of chyluria was commonly associated with hydrocele. In females it was mostly associated with elephantiasis.

Among the persons clinically examined 5.2% of the males and 2.7% of females gave a history of prior filarial diagnosis and treatment. Among those diseased 11.6% of the males and 42.9% of the females were already under treatment for filariasis at the time of examination. The lowest age at which clinical filariasis could be confirmed was 7 years. Two 7 year old female children, one with filarial fever, and the other with thickened lymphatic trunk, were detected during the survey. Though adenitis alone was prevalent among children below seven years, filariasis could not be confirmed in the absence of any other associated manifestations of the disease. The median age of persons with most of the chronic presentations was around 50 years. The median age of acute signs of filariasis was around 20 years.

6.3.2. Microfilaraemia associated with clinical manifestations:

Out of 207 people having filarial manifestation, only 18 (1 female and 17 males) persons had associated microfilaraemia. Sixteen of the seventeen males had hydrocele. The other male had lymphvarix. Eleven of the hydrocele patients had associated lymphadenitis and two had associated history of chyluria. Five of the hydrocele patients had associated funiculitis or epididymo-orchitis of the other testicle as well. The single microfilaraemic diseased female had elephantiasis of lower limbs. The microfilaria count of the 18 diseased microfilaraemic persons varied from 1 to 101 (20c.mm. blood). The mF count of the single case of elephantiasis was 1. The patient with lymphvarix had an mF count of 10.

In an earlier study conducted in Pondicherry by Nair (1960), hydrocele was reported in 50.8% of diseased males. Elephantiasis of lower limbs was detected in 50.9% of diseased females. Though there was no change in predominant clinical manifestations in the present study, a significant difference in prevalence of these presentations was observed. The proportion of diseased males with hydrocele was found higher (86.9%) compared to an earlier report of 50.8% (Nair, 1960). Similarly among females a higher proportion (82.4%) had elephantiasís of lower limbs compared to that observed by Nair (1960) (50.9%). This increase in chronic disease manifestations is due to accumulation of persons having these clinical presentations with time.

It is opined that DEC therapy can reduce morbidity and one would expect a reduction in morbidity pattern in Pondicherry since the surveillance and chemotherapy is reported to be in vogue for more than 30 years. However, the high mor-

bidity observed clearly indicates that the case detection and chemotherapeutic coverage is grossly inadequate.

The higher disease rate in males is attributed to the following reasons. The detection of filarial manifestations in males is relatively easy due to preferential involvement of external genitalia. Further the exposure to mosquito bites in males is higher than in females, due to their outdoor sleeping habit and relatively scanty clothing. In a study conducted at VCRC, it was found that, among the microfilaraemic persons, a significantly higher proportion of males (25.2%) had outdoor sleeping habit compared to females (10.96%), ($P<0.05$).

6.4. Cost effectiveness of the IVM programme

In the VCRC operated zones at the end of five years, only three new microfilaria carriers were detected in the age group less than five years. The mF rate in this age group was reduced from 2.39% (23/963) in 1981 to 0.21% (3/1405) in 1986.

Due to IVM programme, 30 children were prevented from becoming mF carriers for a population of 1405 or 21 per thousand children of this age group at the end of five years. If the figures are further extrapolated to the entire study area, since the population structure for this age group is 14.5% for India (1981 census), out of 23,722 children of this age group in Pondicherry, instead of expected 567 children only 50 children of this age group became microfilaria carriers. In other words, 517 children were saved from becoming infected due to IVM programme. This is significant considering the fact that the parasite load in the community had not undergone any change in the absence of any concentrated efforts to administer DEC to microfilaria carriers.

It is also not illogical to assume that there was a significant reduction in new cases of microfilaria carriers in the other susceptible age groups also, but this cannot be measured precisely.

When one considers the total morbidity due to chronic manifestations of the disease, the benefit accrued due to IVM programme to the people of this area cannot be evaluated adequately.

However, in terms of money spent the VCRC spent a total of Rs. 5.24 million over a period of five years covering a population of 163,600. This worked out to be Rs. 6.4 (US $0.50) per head per year.

A phrase by Andre Gide has never seemed so striking as when applied to the objective of health for all and the path of primary health care which leads to it. "We enter the beneficial world of reality through the narrow gate of Utopia". Surely it is not fanciful to describe as Utopia the presentation of a new model intended to do away with the inadequacies of present health services. If we begin by declaring that the changes envisaged are impossible to achieve, *it becomes a fine excuse for not making the necessary creative effort.*

COMLAN A. A. QUENUM

7. SUMMARY

One of the major aims of the Pondicherry project was to reduce the transmission of filariasis by lowering the vector density to the minimum level possible by IVM strategy. No special efforts were made by the VCRC to augment the chemotherapeutic treatment of mF carriers supposed to be carried out routinely by the State Government. Therefore no drastic change in the overall microfilaria rate of the population was expected. A drastic reduction in the number of new microfilaria cases among children born during the project period was however expected.

1. The mosquito population was reduced drastically in VCRC operated zones, which is reflected in the drastic fall in indoor resting and man biting density, whereas the density did not show appreciable reduction in NFCP controlled areas where routine methods were used. The resting density was maintained at a very low level throughout the project period in VCRC areas.

2. The annual transmission index (Beye and Gurien, 1960) and the risk of infection index (DeMeillon *et. al*, 1967) were also reduced drastically. This is also reflected in the mf rates in the age group 0–5 years (2.39% in 1981 to 0.21% in 1986) in VCRC areas. Only three children out of 1409 in this age group were positive for mF.

3. The mF rate in the population was reduced significantly from 8.93% to 6.34%. Since no significant chemotherapeutic measures were undertaken there was only a slight reduction in MFD50 in the population from 4.48 to 4.04 and therefore the parasitic load in the community remained almost unchanged. In VCRC areas because of effective control measures against the vector there was a marked fall in the intensity of transmission, which was one of the objectives of the project. This was also reflected in the drastic reduction in the incidence rate from 3.65 per thousand in 1981 to 1.04 in 1986.

4. The most important aspect of this study is the clear demonstration that only Integrated Vector Management techniques, with main emphasis on environmental sanitation and making vector control a multi-departmental affair, can bring about a drastic reduction in man vector contact. The techniques of using Integrated Vector Management strategies in other similar situations have also now been perfected.

5. Considering the fact that we are dealing with an ubiquitous species like *Cx. quinquefasciatus*, with very high reproductive potential, the reduction of vector density to a very low level and maintaining at the same level for the entire duration of the project was very significant and the optimum possible under the circumstances. A much higher input would be necessary not only to further reduce the density below the level achieved but also to maintain this at the low level for an indefinite period. This is mainly because we are dealing with a situation where unplanned urbanization had created breeding grounds of gigantic proportions, where sanitary system is virtually non existent and where many departments had contributed to the creation of mosquitogenic conditions and due to political, administrative and other reasons, cannot rectify the situation without a major change in the strategy.

6. Inspite of our best efforts three new cases of microfilaraemia occurred in the area. It can, however, be assumed that but for the IVM programme many more new cases would have occured. The three new cases indicate that the transmission could not be prevented completely in Pondicherry where the parasite load continued to be high. To reduce the infectivity of the population to mosquito, administration of drug to every mF carrier is necessary in a high endemic area like Pondicherry. Otherwise the potential reservoirs will continue to be in the population for vector infection.

7. Due to ubiquitous breeding nature of *Cx. quinquefasciatus*, while eradication should be the goal, this cannot be achieved. One should aim at stabilizing vector population at a very low level, by striking a balance between man, mosquito and environment. No sophisticated technology is required and with simple sanitary measures it is possible to reduce vector density to very low levels as demonstrated in Pondicherry.

8. If the density of vector is reduced drastically and maintained at a low level for a prolonged period, transmission could be cut completely. Therefore, intensified vector control measures should be a continuous programme.

9. Intersectoral collaboration for environmental management cannot be achieved through committees. The committees, as we have found to our dismay, debates, discusses and delays decision making. The political will to do good has to be there. Eventhough many far reaching decisions were made by the high level committee, which could have solved the problem permanently, the problem only got aggravated, due to vested interests and due to political reasons.

10. Mere construction of drains will not solve the problem. There should be proper gradient and adequate provision for proper maintenance, which is just not there. Substandard constructions are very common. To rectify the defects, more capital incentive projects are created which are again not implemented properly. The ultimate beneficiary is the contractor.

11. Community participation in an urban area through motivation and education is a far cry and only strict enforcement of Public Health Act with penal provisions might produce better results. The Singapore 'Destruction of disease bearing insects Act' is the model which should be followed. Present administrative structure is also not conducive for achieving community participation, as the programmes are conceived in isolation without considering the real needs or priorities of the people.

"It was not a campaign that introduced new techniques, but a campaign that illustrated what could be accomplished by application of already known techniques, and applying them more vigorously than ever before, coupled with political sagacity and bulldog tenacity".

WILBUR DOWNS 1981

8. CONCLUSION

It is well known that the national programmes for disease vector control in India have not achieved the objectives to the desired extent. The reasons are many. Where control of urban vector of bancroftian filariasis, *Cx. quinquefasciatus*, is concerned, it did not at one time pose any problem because the technology for control of *Cx. quinquefasciatus* is well known and it was thought that there is only an operational deficiency due to lack of adequate resources. That was the reason why the VCRC took up a time bound Filariasis Control Demonstration Project where the Integrated Vector Management technology was followed.

It was realized that urban mosquito control is beset with several problems which defy easy solution. In India, and probably in many other developing countries, there has been unplanned urbanization and the sanitary services did not match the growth of the towns. It would be very difficult to sustain a programme of mosquito control over a long period under such situation. Moreover, the average urban dweller (a majority of them) is not so much bothered to do anything about mosquitoes biting them, since he has several other problems to worry about and he has taken mosquito nuisance for granted. Therefore there is no vociferous demand by the people to have anything done about it.

There is no mosquito control programme *per se* in India. Vector control is a part of the disease control strategy under the health department. During epidemics of malaria and JE in India the health departments do something for vector control. In the case of filariasis, where nobody dies, the disease process is very slow and the lower strata of society suffers, no serious effort is made for controlling the vectors. This is just a routine operation carried out only in some places.

Urban mosquito problem could be solved by better sanitation, preventing water stagnation and allowing water in the drains to flow. But in most of the towns and cities water is stagnating everywhere due to several reasons. Piecemeal construction of drains which are without proper gradients or with dead ends, blocking of drains by garbage thrown by people, due to lack of implementation of civic acts, etc. are some of the reasons.

If the people could be made to see the difference of living a life free from mosquito bites or with very fewer number of mosquitoes biting them for a period of at least five years, they would be able to force the events and would insist on corrective action.

During the five year project period, the VCRC did keep the mosquito nuisance within manageable limits. While the project was on, both the public as well as the State Government applauded the results. It was thought that may be the authorities do not have resources earmarked specifically for mosquito control. But even this was done. While the VCRC was spending about Rs. 800,000 per year, the State Government was given an additional grant of Rupees One Million per year by the Planning Commission specially for mosquito control from April 1986 onwards. It remains to be seen whether finances were the only constraint in the past.

The available technology for *Cx. quinquefasciatus* control is simple and adequate and its implementation should be possible within the existing administrative set up provided there is a realization that if mosquito breeding is prevented, several diseases could be automatically controlled. This realization is not there. The attempt is always to treat the symptoms and not the cause.

Waste water & sewage disposal and sanitation are professional jobs which should be carried out by trained public health engineers. In local bodies the health officers are given the responsibility to keep the drains free from mosquito breeding but they are unable to do a perfect job because of faulty constructions, nonfunctional and blocked drains and the health officers have no say in the matter. The entomologists are nowhere in the picture as far as mosquito control is concerned. Vector Control in urban area should be linked with sanitation which alone will be cost effective. Suitable changes should be effected in the administrative structure to aim at optimal utilization of existing infrastructure and resources by redis-

tributing the functions to appropriate departments.

Urban vector control is possible provided that there is enough political will and managerial skill, and people who are appointed for a particular job are made accountable.

"Not houses finely roofed nor the stones of walls well-builded; nay, nor canals and dockyards make a city, but men able to use their opportunity.

Those who fail to use their opportunity may continue to get the environments they deserve".

—J. DOUGLAS PORTEOUS

STATISTICS AT A GLANCE

FILARIASIS CONTROL DEMONSTRATION PROJECT (VCRC)

1. AREA UNDER OPERATION: 59 Sq. km.
   (a) IVM (VCRC) : 48 Sq. km.
   (b) ROUTINE (NFCP) : 11 Sq. km.

2. POPULATION COVERED : 2,72,250 (1981 CENSUS)
   (a) IVM (VCRC) : 1,63,590
   (b) ROUTINE (NFCP) : 1,08,660

3. MICROFILARIA RATE :

	1981	1986
PONDICHERRY :	8.41%	6.34%
(a) VCRC ZONES :	8.93%	6.35%
(b) NFCP ZONES :	7.57%	6.33%

4. BREEDING POTENTIAL :

TYPES OF HABITATS	VCRC ZONES (Sq.mts.)	NFCP ZONES (Sq.mts.)	TOTAL (Sq.mts.)
(a) CESSPITS/CEMENT TANKS	1,878	270	2,148
(b) CESSPOOLS/VACANT PLOTS	44,468	5,978	50,446
(c) DRAINS	37,748	17,138	54,887
(d) WELLS	3,169	1,722	4,891
(e) CANALS	2,253	2,772	5,025

5. CONTROL OPERATIONS IN VCRC ZONES:

PARTICULARS	1981	1982	1983	1984	1985
(A)CHEMICAL CONTROL					
(i) SURFACE AREA COVERED(Sq.mts)	2,366,118	2,455,974	2,362,500	3,390,000	3,175,040
(ii)CONSUMPTION OF INSECTICIDES(Lts)	691	920	875	1,255	1,218
MALARIOL(Lts)	17	377	460	3,050	1,312
(iii)COST OF INSECTICIDES(Rs.)	113,000	160,000	150,000	260,000	252,225
(iv) COST OF LABOUR(Rs.)	73,000	104,000	84,000	120,000	129,744
(v) TOTAL COST(Rs.)	186,000	264,000	234,000	380,000	381,969
(B)ENVIRONMENTAL CONTROL					
(i) SOURCE REDUCTION					
FILLING(Sq.mts)	14,672	4,427	4,130	1,008	2,569
CHANNELIZATION(Sq.mts)	1,146	3,253	4,700	10,400	NIL
(ii)SANITATION(Sq.mts)					
CLEANING AND DESILTING	227,671	1,074,242	3,164,578	925,850	1,377,769
(iii)PUMPING(Sq.mts)	6,371	12,764	31,725	NIL	NIL
(iv) TOTAL COST(Rs.)	64,000	71,000	134,000	131,281	230,313
(C) BIOLOGICAL CONTROL					
COST OF FISH COLLECTION AND RELEASE(Rs.)	8,320	16,000	25,230	13,887	6,000

6. TOTAL EXPENDITURE (in Rupees)

PARTICULARS	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86
BY VCRC	5 72,602	6 07,245	13 22,829	8 49,798	9 12,083	9 75,761
BY GOVT. OF PONDICHERRY	-	50 07,963	23 54,721	22 10,941	30 36,494	13 56,309

7. ENTOMOLOGICAL EVALUATION

PARTICULARS	1981	1982	1983	1984	1985
(i) NO. OF CX. QUINQUEFASCIATUS COLLECTED					
(a) RESTING	25,380	24,487	17,687	12,614	15,213
(b) BITING	3,505	1,962	1,956	2,213	3,774
(ii) NO. OF CX. QUINQUEFASCIATUS DISSECTED					
(a) RESTING	19,116	18,080	12,767	8,864	10,933
(b) BITING	3,635	1,983	1,639	1,832	3,360

8. EPIDEMIOLOGICAL EVALUATION

	1981	1986
i) NO. OF BLOOD SMEARS COLLECTED	24,946	34,615
ii) NO. OF PERSONS CLINICALLY EXAMINED	-	6,493

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DR. P. K. RAJAGOPALAN,
Director

Great is Sanitation, the greatest work, except discover
I think, that a man can do....What is the use of preaching high
moralities, philosophies, policies and arts to people who dwell in
appalling slums...? You must wipe away those slums, that filth,
these diseases....We shall reach the higher civilization, not by a
of the politicians' shibboleths, methods of government, manners o
voting, liberty, self-determination, and the rest, all of which have
failed-but first by the scientific ordering of cities until they are
fit for men of the higher civilization to dwell in. We must begin
by being Cleansers.

— Sir Ronald Ross